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魚類血液の生化学的研究–XV

—血清蛋白質と色素イオンの結合性にみられる種属特異性—

斎藤　要

Biochemical Studies on the Fish Blood-XV

On the Species Specificity in the Combination of Serum Protein with Anionic and Cationic Dyes

Kaname Saitō

Abstract

Combination of fish serum protein with a cationic dye, methylene blue and with two anionic dyes, methyl orange and bromophenol blue, was studied by equilibrium dialysis, paper electrophoretic analysis and spectrophotometry. The results obtained were summarized as follows.

1) As to the binding ability with methyl orange of various serum proteins, it was ascertained that a considerable amount of methyl orange can be bound with the serum protein of teleosts such as, *Scomber tapeinocephalus*, *Niphon spinosus*, *Chrysophrys major*, *Thunnus thynnus*, *Coryphaena hippurus* and *Mugil cephalus*, and also with the mammalian serum protein (rabbit and bovine), but to the serum protein of elasmobranchs such as *Dasyatis akajei*, *Mustelus griseus*, *Orectolobus japonicus* and *Carcharhinus albimarginatus*, such binding ability wae barely observed. (Fig. 1). While, the amount of methylene blue bound to serum protein was found to be quite small in any cases. (Fig. 2). In case of teleosts, the binding ability with methyl orange of serum protein varied with kinds of fish and was found in the following order.

Bovine (control)＞*Scomber tapeinocephalus*, *Thunnus thynnus*＞*Chrysophrys major*, *Mugil cephalus*.

2) In the electrophoretic diagrams obtained from the mixture of serum and bromophenol blue, in case of teleosts and control animals there were two peaks of A and B, while in elasmobranchs there was one (A) peak only. (Fig. 5). Peak A (purple) is occassioned by free bromophenol blue and Peak B (blue) is brought forth by the combination of albumin fraction and bromophenol blue. Namely, in case of serum protein of teleosts and control animals there were observed the combination of bromophenol blue with albumin component and a metachromasis according to this combination, but in case of serum protein of elasmobranchs no such phenomenon could be observed.

3) In the adsorption spectra obtained from the mixture of serum and bromophenol blue, in case of elasmobranchs the adsorption maximum was observed, as in the case of free bromophenol blue (blank), at about 595 mμ, while in teleosts and control animals the maximum was at about 605 mμ. (Fig. 6). That is, the serum protein of elasmobranchs does not show metacromasis. In the case in which methylene blue and congo red were used in place of bromophenol blue no such difference in adsorption maximum was found between any samples. (Fig. 7 and 8). From these results it has been ascertained that the serum protein of elasmobranchs, unlike that of teleosts or higher vertebrates, is lacking in albumin component which is rich in cation radicals.

1. 色素イオンの結合能*

最近，蛋白質と色素イオンとの結合量を測定して，蛋白分子内にある近づき易く，且つ自由にイオン化出来る基を簡単に定量することが可能となり，これによつて蛋白質の性質とか組成を比較し得るようになつた．

Klotz 等[1]の研究によつて，哺乳動物では血清蛋白質の種類により色素イオンの結合量が著しく異ることが明らかにされているから，各種動物の血清蛋白質について色素イオンの結合量を求め，これを比較検討することにより組成の一端を伺うことも可能と考えられる．しかし魚類を対象としたこの種の研究は未だ行われていないようである．

著者は平衡透析法によつて魚種別に血清蛋白質と色素イオンとの結合量を求めたところ，硬骨魚類と軟骨魚類とでは該蛋白質と methyl orange (anion) との結合量に著しい差異のあることと，その差異は前報[2,3,4]で述べた魚類血清蛋白質の組成にみられる種属特異性と密接な関係のあることを確認し得た．

実　験　の　部

実 験 材 料

実験材料の選択にあたつては前報[5]で述べた事項に留意し，同種の材料には出来得る限り環境及び生理，生態的諸条件の類似したものを用いた．

魚種：供試魚の種名と各々の平均体重を示すと次の如くである．

硬骨魚類		
コ　イ	*Cyprinus carpio* (LINNÉ)	530 g
ボ　ラ	*Mugil cephalus* LINNÉ	480 g
マダイ	*Chrysophys major* TEMMINCK et SCHLEGEL	710 g
ア　ラ	*Niphon spinosus* CUVIER et VALENCIENNES	1,420 g
シイラ	*Coryphena nippurus* LINNÉ	1,010 g
ゴマサバ	*Scomber tapeinocephalus* BLEEKER	960 g
カツオ	*Katswonus Pelamis* (LINNÉ)	1,310 g
マグロ	*Thunnus thynnus* (LINNÉ)	71 kg
軟骨魚類		
シロザメ	*Mustelus griseus* PIETSCHMANN	2,180 g
オオセ	*Orectolobus japonicus* REGAN	22 kg
ツマジロ	*Carcharhinus albimarginatus* (RÜPPLL)	14 kg
アカエイ	*Dasyatis akajei* (MÜLLER et HENLE)	1,890 g
ツノザメ	*Squalus mitsukurii* JORDAN et FOWLER	11 kg

対照動物としては人間，家兎及びウシを用い，また標準血清蛋白質としては精製 albumin (米国. Armour Lab. 牛血製) を用いた．

採集の時期と水域：供試海産魚類は 1958 年 10月から 1959 年 3 月までの間に鹿児島湾及びその近海で採集したもので，当時の水温は表層で 17～19°C，100 米層で 13～14°C を示

* 本報告は 1959 年 4 月日本水産学会年次大会（東京）て発表した．

した．またコイは鹿児島市内の養魚池より同時期に求めたもので当時の水温は 10～14°C であつた．

実　験　方　法

採血法：採集直後直ちに，魚体の胸部或は鰓孔の後部膜を切開して心臓を幾分露出させ，注射針を動脈球から心室の方向に入れ，心臓の収縮期に従つて採血した．

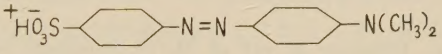
血清の分離法：血液を氷蔵庫（4～6°C）中に約 6 時間放置した後に遠心分離（3,000 r.p.m. 10 分間）して得られる血清を使用した．

血清蛋白質溶液の調製：分離した血清をセロファン紙嚢に入れ，Mol/15 燐酸塩緩衝液（pH 7.3）中において約 4°C で 20 時間透析した後，所定濃度（蛋白態窒素 2.5～3.0mg/5 m*l*）の溶液を調製した．なお必要に応じて血清をそのまま同緩衝液で所定濃度の蛋白質溶液となるように稀釈して用いた．

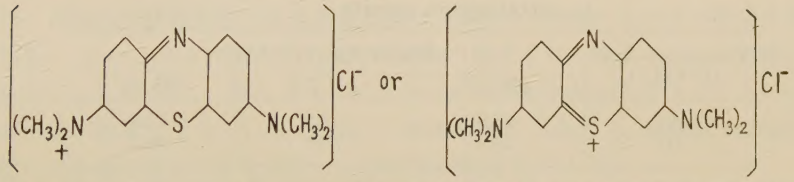
結合量の測定法：Klotz 氏[6]の用いている平衡透析法に準拠した．即ち色素溶液と蛋白質溶液をセロファン膜で界し，両者が平衡に達した後，色素溶液の濃度を測定し，一方対照として蛋白質を含まないだけで，その他は同一条件とした場合の色素溶液の濃度を測定し，両者の差から蛋白質と結合した色素量を算出した．

色素としては anion の methyl orange（国産特級品の再結晶品）と cation の methylene blue（Merck 製，化学用）を用いた．

methyl Orange



methylene blue



実施にあたつては右田，大竹氏等[7]の透析法を若干変更し，次の如く行つた．

透析器：セロファン紙はかなり色素を吸着するので表面積の僅かな差も大きく影響することになる．methylene blue の場合は特にこの傾向が強くみられた．そこで表面積を一定にするため著者は直径 31 mm，長さ 60 mm の硝子管の一端にセロファン紙をはりつけた透析器を用いた．

管の側面にセロファン紙を密着させるためゴムバンドを数回まき，その上に融点約 60°C のパラフィンを塗り，ゴムバンドの部分とセロファン紙の折り曲げた部分を完全にパラフィンで覆う．セロファン紙は予め蒸留水で 30 分間煮沸した後，新しい蒸留水に一夜浸漬したものを用いた．また用いたセロファン紙は略々均質とみなし得ることは一枚の紙から 9 個の切片を切り各々前記の如くして作つた透析器を用いて，methyl orange（濃度 10×10^{-5} Mol/*l*）を溶媒に対し透析し，平衡達成後，色素の濃度を測定した結果，信頼限界度 $5.52\pm0.04\times10^{-5}$Mol/*l* を得たことから諒解される．

透析操作：前記の血清蛋白質溶液 5 m*l* を透析器内に入れ，これを一列の濃度の色素溶液 10 m*l* を入れた管瓶中に各々浸し，管瓶にゴム栓を施し，6～8°C の冷室に 48 時間静置す

る．なお管瓶底面と透析器のセロファン紙とが密着しないように，直径約 3 mm の硝子棒を三角形に折り曲げたものを敷いて，その上に透析器を置いた．

色素の結合量及び結合能力の比較：平衡達成後，色素溶液槽中の色素濃度を比色定量する．(EPO–II 日立光電光度計，液層巾 1 cm，測定波長 methyl orange 溶液では 460 mμ，methylene blue溶液では 670 mμ)．この濃度〔A〕は結合に与らなかつた色素の濃度である．同様にして対照（色素溶液—蛋白質の溶媒系）における色素の平衡濃度〔A_0〕を求めると，〔A_0〕−〔A〕から蛋白質と結合した色素の量がわかる．この結合量から各種血清蛋白質の色素に対する結合能力を比較するため，色素濃度を広い範囲に変化させて検討し，Klotz 氏等[6]に従い色素濃度〔A〕（対数目盛）と蛋白態窒素 1 mg 当りの色素結合量 γ との関係を図示した．

実 験 結 果

A. 実験条件の吟味

結合量の測定は前述の平衡透析法によつたが，更に二・三の実験条件について検討した．

緩衝液の pH と色素濃度の影響：Klotz 氏等[8]のウシの血清 albumin についての結果では，燐酸イオンは色素と蛋白質の結合を妨げることが最も少ないとされている．そこで本実験でも燐酸塩緩衝液（Mol/15KH_2PO_4—Mol/15 Na_2HPO_4 混液）を用いたが，次に家兎の血清蛋白質を試料とし，methyl orange との結合に及ぼす緩衝液の pH と色素濃度の影響について検討した結果を Table 1 に示した．

Table 1. Influence of pH of M./15 phosphate buffer solution upon the binding of methyl orange to rabbit serum protein.

Concn. of dye (10^{-6} M./l.)	Bound dye (10^{-8} M.)		
	pH 5.3	pH 7.3	pH 8.7
40	13.5	13.5	13.8
80	28.5	28.8	29.2

Equilibrium dialysis : 5 ml. of protein solution (prot.-N concn. 2.5～3.0 mg./5 ml.) in the inside cell was dialyzed against 10 ml. of dye solution in the outside cell through cellophane for 48 hr. at 6～8°C. Control dialysis was set up in order to make correction for adsorption of dye on membrane itself. Amount of bound dye was calculated from the difference in the equilibrium concentration of free dye in the outside cell between protein-containing dialysis system and control.

この結果によると，実験の pH 域では何れの pH でも結合量に大差のないことが諒解され，このような結果はコイ及びシロザメの血清蛋白質の場合にも認められた．更に色素濃度を 2 倍にしても結合量が 2 倍になるとは限らないことも明らかである．

以上の結果に基き本実験では血清の生理的 pH に近い pH 7.3 の燐酸塩緩衝液を使用し，色素濃度を比較的広い範囲に変化させて実験した．

緩衝液中の蛋白質濃度の影響：対照試料とした標準血清 albumin とウシの血清蛋白質を用い，これらと methyl orange の結合に及ぼす蛋白質濃度の影響について検討した結果を Tabel 2 に示した．この結果によると，試料液の蛋白質濃度が増加しても，それに比例して結合量は増加しないことが認められる．従つて本実験では，蛋白質濃度が 2.5～3.0 mg/5ml になるように条件を規定して実験した．

Table 2. Influence of protein concentration upon the binding of methyl orange to serum protein.

Sample	Concn. of protein (N mg./5 ml.)	Bound dye (10^{-8} M.)
Albumin*	4.0	28.5
	2.0	19.5
	1.0	11.2
Bovine**	6.0	22.2
	3.0	15.4
	1.5	8.7

Concn. of dye 40×10^{-6} M./l., M./15 posphate buffer solution pH 7.3.
* The bovine serum albumin was obtained from Armour Laboratories (U. S. A.).
** Dialyzed serum.

B. 血清蛋白質と methyl orange 及び methylene blue との結合

透析血清の結合曲線：前述の条件で調製した供試材料の血清蛋白質溶液を用い，methyl orange 及び methylene blue の所定濃度における該蛋白質の色素結合量 r を求めて得た結合曲線は Fig. 1 及び 2 の如くである．なお，この結果は各材料とも 6～10 個体について求めた値の平均値である．

Fig. 1 の〔A〕は対照とした標準血清 albumin とウシの血清蛋白質の結合曲線であるが，両者共に methyl orange の濃度に応じてかなりの結合量を示すことは明らかである．また単位蛋白態窒素量当りの結合量は前者が後者よりかなり多い結果となつている．

次に図の〔B〕，〔C〕は硬骨魚類に属するボラ，マダイ，アラ及びゴマサバ等の結合曲線であるが，これらの硬骨魚類でも血清蛋白質は methyl orange とかなり結合することは明らかである．しかし各々の結合能力は対照動物の場合より一般に小さく，魚種により若干の差があることも伺える．即ちゴマサバとかマグロの如き洄泳魚はマダイとかボラ等より結合能力が高い結果となつている．魚肉の actomyosin に対する methyl orange の結合量にも魚種による差のあることを右田，大竹氏等が報告[7]している．

図の〔D〕は軟骨魚類に属するシロザメ，オオセ，ツマジロ及びアカエイの結果であるが，これらの魚類の場合は血清蛋白質と methyl orange との結合が明らかでない．即ち対照動物及び硬骨魚類の場合に比べ結合能に著しい差異が認められる．

Fig. 2 は cation 色素である methylene blue の場合の結果であるが，これによると対照動物及び各供試魚共に血清蛋白質と methylene blue との結合能は極めて小さいことが諒解され，anion 色素の場合にみられたような顕著な種属的差異は認められない．

原血清の結合曲線：軟骨魚類と硬骨魚類とでは血清の成分組成，特に非蛋白態窒素化合物量[5]に著しい差異がある．そこで，これらの物質（主として尿素と trimethylamine oxide）が共存した場合の影響を知る意味で，透析処理をしない原血清を用いて methyl orange との結合曲線を求めてみた．その代表的な結果が Fig. 3 である．

これによると，各試料とも原血清の場合も透析血清の場合と略々同様な結合曲線を示すことが諒解される．Klotz 氏等[9]は高濃度の尿素が血清 albumin と methyl orange との結合を妨げるばかりでなく，既に出来上がつている結合をも切ると報告しているが，本実験条件下では原血清（供試軟骨魚の血清尿素量 762～897 mg/dl）をそのまま使用しても血清蛋

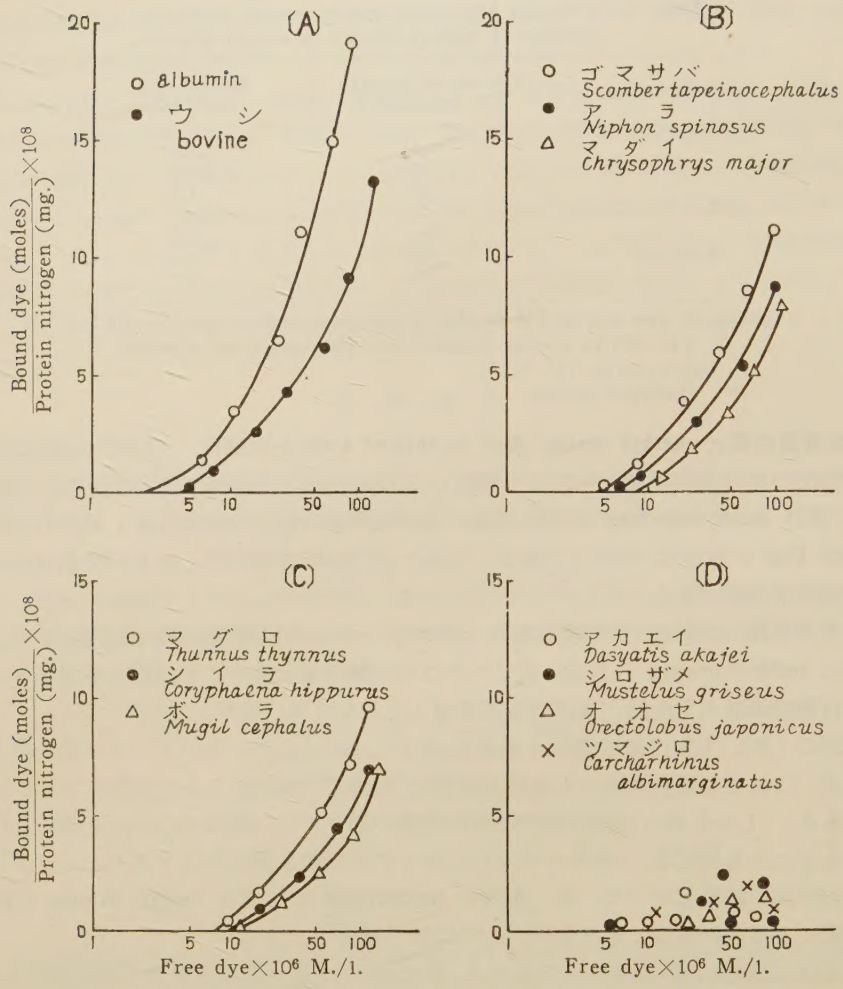


Fig. 1. Binding of methyl orange to serum proteins of fishes and bovine in phosphate buffer solution at pH 7.3.
〔A〕: Control. 〔B〕: Marine teleosts. 〔C〕: Marine teleosts.
〔D〕: Marine elasmobranchs.

白質と該色素の結合性に対する共存成分の影響は殆んどないことが明らかである.

混合血清の結合曲線：前述の如く軟骨魚類の血清蛋白質は methyl orange との結合が顕著でないが，これに結合の顕著な標準血清 albumin 及び他の供試血清を種々の割合で混合した場合についても結合量を求めてみた. 次に等蛋白質量混合液について得られた結合曲線を Fig. 4 に示した.

この結果よりも明らかな如く，シロザメとかアカエイ等の血清に標準血清 albumin, ウシ及びマダイ等の血清を混合すると色素濃度に応じてかなりの結合量を示すようになる.

このような傾向は透析血清を用いた混合血清の場合にも同様に認められた. なお軟骨魚類の血清には生理的 pH に近い燐酸塩緩衝液の添加によつて沈殿する易動度の極めて低い特殊な蛋白質の存在することを発見[10]しているが，この蛋白質を透析管中に共存させた場合

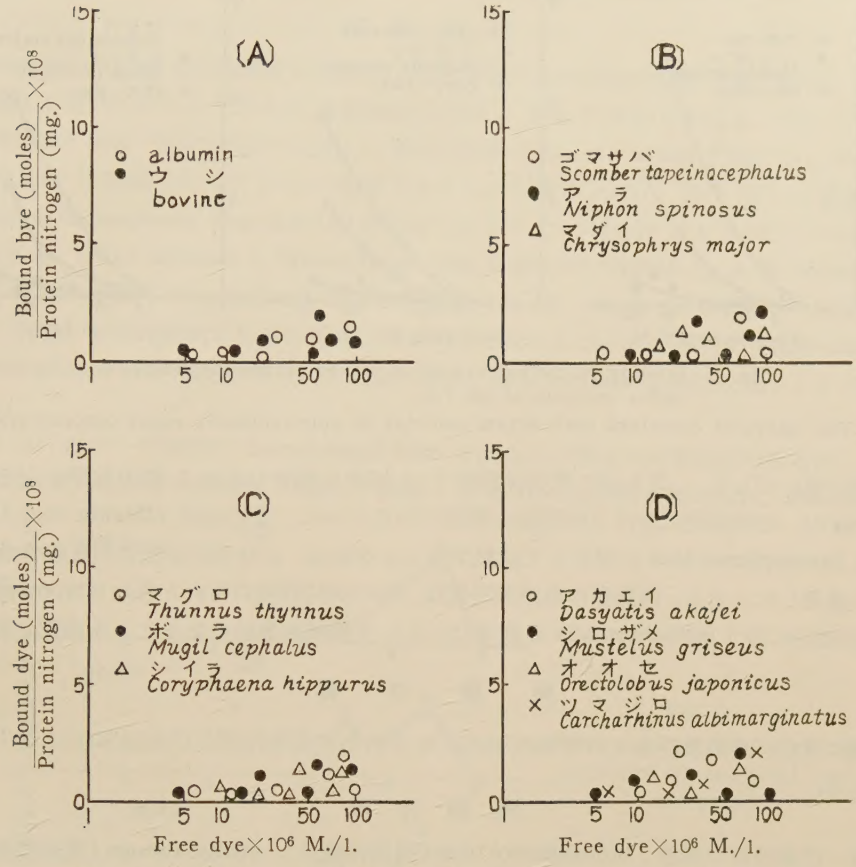


Fig. 2. Binding of methylene blue to serum proteins of fishes and bovine in phosphate buffer solution at pH 7.3.
〔A〕: Control. 〔B〕: Marine teleosts. 〔C〕: Marine teleosts. 〔D〕: Marine elasmobranchs.

も除去した場合も両色素の結合性に殆んど変化のないことを確認している．

2. 色素イオンによる変色性 (metachromasis)*

A. 血清と色素混液の泳動図にみられる metachromasis

魚類の血清蛋白質の濾紙電気泳動法による分析結果については前報[3]で述べたが，著者はその実験中に血清蛋白質と bromophenol blue との結合現象について興味あ

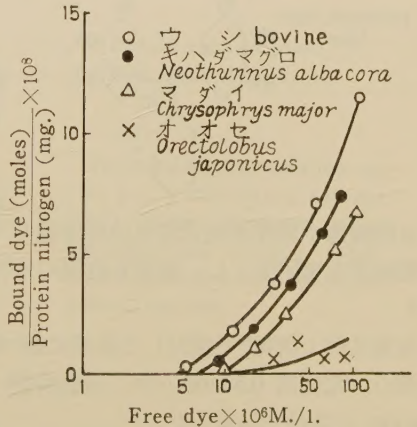


Fig. 3. Binding of methyl orange to serum of fishes and bovine in phosphate buffer solution at pH 7.3.

* 本報告は 1958年11月，日本水産学会九州大会で発表した．

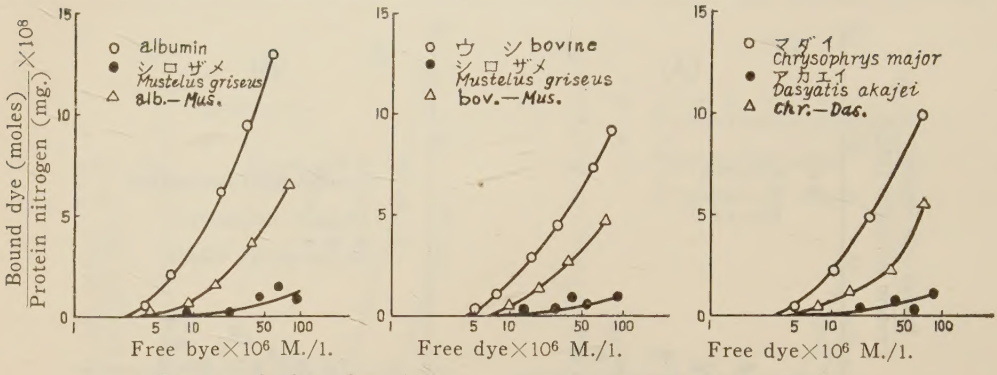


Fig. 4. Binding of methyl orange to mixed serum in phosphate buffer solution at pH 7.3.

△ The mixtures contained each serum proteins in approximately equal concentration.

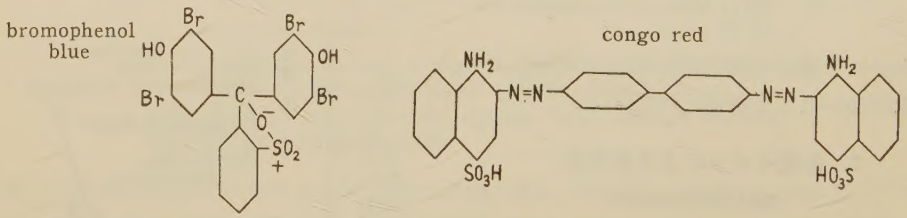
る事実を見いだした. 即ち濾紙電気泳動法では相対易動度を求める際の基準となる血清 albumin の一定時間後における移動量を簡単に知るために, 予め血清 albumin 又は人間の血清に bromophenol blue を混合して泳動することがある. この方法をたまたま軟骨魚類の血清に適用したところ, 同魚類の血清蛋白質は, 他の供試動物の場合と異なり bromophenol blue の結合に伴う metachromasis を起さないという種属特異性のあることを確認し得た.

実 験 の 部

実験に供した魚種及び各々の平均体重並びにそれらの採集時期及び水域等は本報 1 と同様である.

実 験 方 法

血清一色素混液の調製：bromophenol blue (国産特級品), methyl orange (国産特級品), methylene blue (Merck 製化学用) 及び congo red (国産一級品) を用い, 各々の血清飽和溶液を調製した.



泳動装置：東洋濾紙式電気泳動装置 C 号を一部改造して用いた. 即ち本装置附属の開放型電極槽を密閉型とし, 装置を自製の氷箱中に納め得るように改造した. (詳細は前報[3]参照)

泳動条件：前報[3]で検討した結果に基づき東洋濾紙 No. 51 と燐酸緩衝液 (pH 7.8, μ 0.1) を用い, 電流値 0.32 mA/cm, 泳動時間 15 時間, 泳動温度 6～8°C, 蛋白質濃度 0.2～0.3 mg/cm の条件で泳動した.

泳動曲線：泳動後の濾紙を乾燥後, 流動パラフィンに浸し, 東洋理化工業式濾紙光電比色計 (S-1 型, filter V-02) によつて求めた.

実 験 結 果

bromophenol blue と血清混液の泳動図：供試血清の該色素飽和溶液を所定条件下で泳動し，濾紙光電比色計により求めた泳動曲線を示すと Fig. 5 の如くである．図の〔A〕は blomophenol blue のみを単独で泳動した場合の結果であるが，anion 色素である bromophenol blue は陽極に向つてかなり移動することが諒解される．図の〔B〕は標準血清 albumin と bromophenol blue 混液の泳動曲線であるが，この場合は A と B の二つの泳動峰がみられる．B は albumin と bromophenol blue の結合物の泳動峰で，A は albumin とは結合しない遊離の bromophenol blue の泳動峰であることは各々の易動度より確認できる．この場合 A 峰は紫色であるのに対し B 峰は青色を呈した．この事実より血清 albumin は bromophenol blue と結合すると共に変色現象，即ち metachromasis を起すことが諒解される．

図の〔C〕はウシの血清に bromophenol blue を混合した場合の泳動曲線であるが，この場合には〔B〕の血清 albumin の場合と同様に A と B の泳動峰が認められ，albumin 以

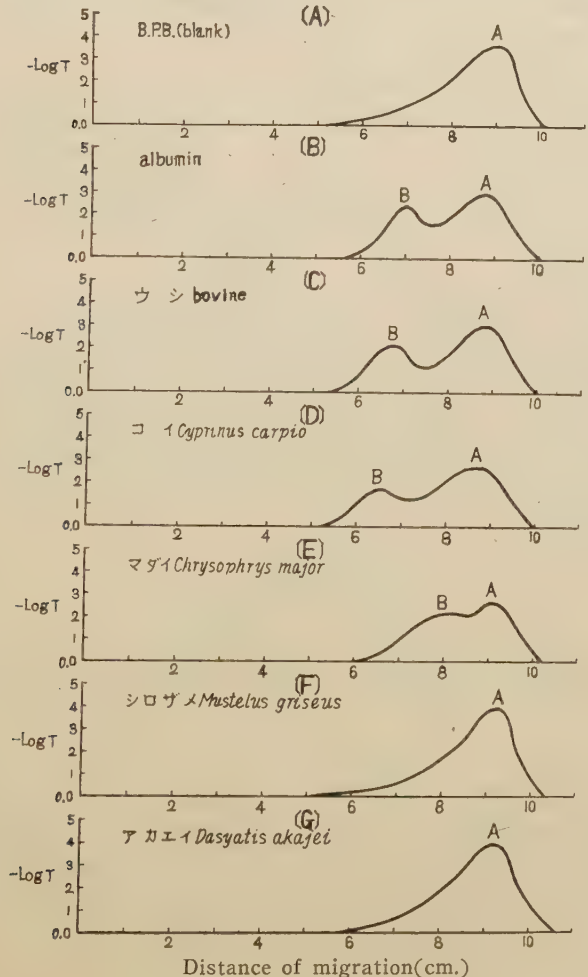


Fig. 5.
Paper electrophoretic diagrams of serum-bromophenol blue mixtures.

〔A〕, 〔B〕 and 〔C〕: Control.
〔D〕 and 〔E〕: Teleosts.
〔F〕 and 〔G〕: Elasmobranchs.

A: Purple colored peak.
B: Blue colored peak.

Phosphate buffer solution pH 7.8; μ 0.1; intensity of current 0.32 m A/cm.; duration of electrophoresis 15 hr.; temp. 6～8°C.; protein concentration 0.2～0.3 mg./cm.

外の蛋白質（α_1, α_2, β 及び γ-globulin 区分）の泳動部分には bromophenol blue による着色，即ち結合が認められない．勿論これらの globulin 区分でも，常法[11]により変性剤（$HgCl_2$）を含む blomophenol blue 溶液で染色すると着色する．（前報[8]参照）

図の〔D〕と〔E〕は硬骨魚類に属するコイとマダイの泳動曲線であるが，これらの場合も対照動物の場合と略々同様に2個の泳動峰と metachromasis が認められる．このような現象は他の供試硬骨魚の場合にもみられた．

一方軟骨魚類に属するシロザメとアカエイでは〔F〕及び〔G〕に示した如く，〔A〕の場合と略々同様な泳動曲線を示す．即ち A の泳動峰のみがみられ，対照動物と硬骨魚類にみられた B の青色の泳動峰は認められない．このような現象は他の供試軟骨魚の場合にも確認された．以上の事実より，軟骨魚類の血清には他の実験材料にみられるような albumin 区分が殆んど存在しないことが証明され，そのために同魚類の血清蛋白質は bromophenol blue と metachromasis を起さないという種属特異性を示すことが諒解される．

他の色素と血清混液の泳動図：平衡透析法では albumin と明らかな結合を示した methyl orange についても同様な条件で泳動図を求めてみたが，本色素は所定時間における陽極に対する易動度が albumin 区分より小さく，bromophenol blue の場合にみられたような同区分との結合とか，それに伴う変色現象が認められなかつた．

この結果より同じく anion 色素であるが bromophenol blue の方が methyl orange よりも，血清 albumin との結合が強固であると推定される．次に cation 色素である methylene blue では血清蛋白質とは逆に陰極側に泳動し，また congo red では通電しても原点附近に止まり，これらの両色素と血清混液の泳動図には種属的差異は全く認められなかつた．

B. 血清と色素混液の吸収曲線*

蛋白質と色素混液の吸収曲線については Klotz[9], Teresi[12] 氏等の詳細な研究がある．

前述の如く，軟骨魚類では血清と bromophenol blue 混液の泳動図に metachromasis が認められないのに対し対照動物と硬骨魚類の場合には顕著な metachromasis が認められた．このような metachromasis が起きると，当然色素原液と混液との間に最大波長の変化が伴うと考えられる．そこで炉紙上で認めた前述の現象を更に確認する意味で分光光電光度計を用い，血清に bromophenol blue 及び他の色素を加えて吸収曲線を求めたところ，metachromasis を更に数値的に解明できた．

実　験　の　部

実　験　材　料

実験に供した魚種及び各々の平均体重並にそれらの採集時期及び水域等は本報 1. と同様である．

実　験　方　法

血清-色素混液の調製：使用した光電光度計の性能を考慮して，種々検討した結果に基き，血清 0.2 m*l* に所定 pH の Mol/15 燐酸塩緩衝液 2 m*l* を加え，これに 0.015% bromophenol blue 溶液 0.1 m*l*，また methylene blue と congo red の場合は 0.01% 溶液 0.1 m*l* を添加して波長の測定に供した．なお標準血清 albumin では蛋白態窒素 1 mg/m*l* の溶液，また

* 本報告は 1958年11月，日本水産学会九州大会で発表した．

透析血清の場合は蛋白態窒素 2.5 mg/m*l* の溶液を調製し，これらの 0.2 m*l* を用いた．

吸収曲線の作成：日立分光光電光度計 EPU-2 型で求めた D を縦軸に，横軸に λ (mμ) をとつて表わした．

実 験 結 果

bromophenol blue と血清混液の吸収曲線：pH 7.3 の燐酸塩緩衝液を用い，前述の条件で調製した bromophenol blue と血清の混液について求めた吸収曲線を Fig. 6 に示した．

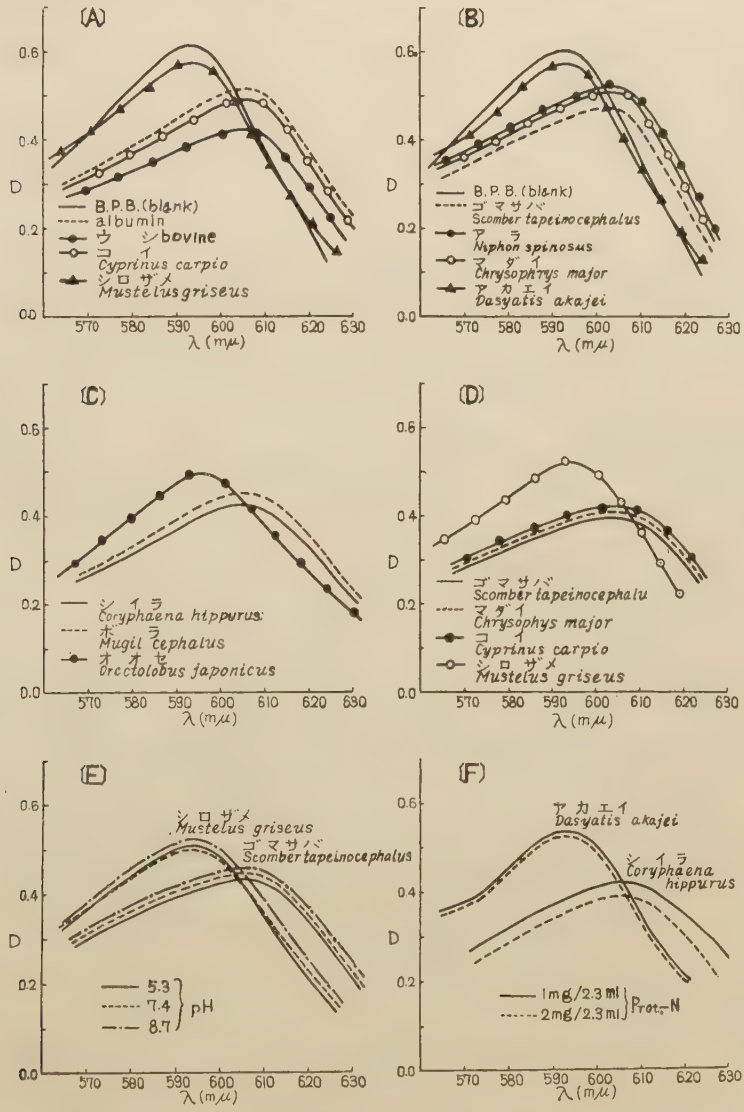


Fig. 6. Absorption spectra of bromophenol blue solution in serum of fishes and bovine.

〔A〕, 〔B〕 and 〔C〕: Original serum. 〔D〕: Dialyzed serum.
〔E〕: Effect of pH. 〔F〕: Effect of protein concentration.

The serum-dye mixture consisted of 0.1 ml. of 0.015 % bromophenol blue, 2.0 ml. of M./15 phosphate buffer solution, and 0.2 ml. of serum.

図〔A〕の結果より，bromophenol blue の blank では最大波長が 595 mμ 附近にみられるのに対し，これに標準血清 albumin とかウシの血清を添加すると最大波長が 605 mμ 附近に変化することが諒解される．

魚類では図の〔A〕，〔B〕，及び〔C〕に示すように，軟骨魚類に属するシロゼメ，アカエイ，オオセ等の血清では bromophenol blue の blank と略々同様に最大波長が 595 mμ 附近にみられるのに対しコイ，ゴマサバ，アラ，マダイ及びボラの如き硬骨魚類の血清では標準血清 albumin 及び対照動物の場合と同様に 605 mμ 附近に最大波長が認められる．

以上の結果より供試軟骨魚類の血清は他の実験材料の血清とは異り bromophenol blue と metachromasis を起さないという種属特異性のあることが明らかである．

この様な特異性は緩衝液の pH を変化（pH 5.3～8.7）させた場合とか，混液中の蛋白質量を変化（窒素として 0.5～2.5 mg）させた場合にも同様に認められた（Fig. 6〔E〕及び〔F〕参照）．

以上は血清をそのまま使用した場合の結果であるが，前述の如く硬骨魚類と軟骨魚類とでは血清の非蛋白態窒素量に著しい差異があるので，蛋白質以外の共存成分の影響を知る意味で，透析処理をした血清についても同様に検討してみた．

その結果を Fig. 6〔D〕に示したが，各試料共に前述の原血清の場合と大差のない結果であつた．これらの事実より原血清の示す metachromasis に対しては共存する蛋白質以外の成分の影響は極めて少ないことが伺える．

他の色素と血清混液の吸収曲線：供試血清と methylene blue の混液について求めた吸収曲線を Fig. 7 に示した．

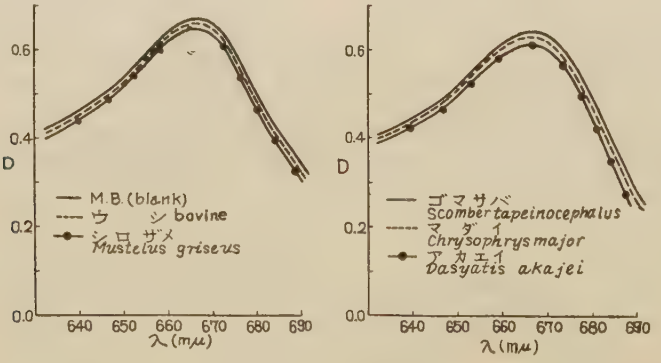


Fig. 7. Absorption spectra of methylene blue solution in serum of fishes and bovine.
The serum-dye mixture consisted of 0.1 ml. of 0.01 % methylene blue, 2.0 ml. of M./15 phosphate buffer solution (pH 7.3), and 0.2 ml. of serum.

即ち本色素の blank では最大波長が 665 mμ 附近にあるが，これに対照動物（人及び家兎），硬骨魚類に属するコイ，ゴマサバ，マダイ及び軟骨魚類に属するシロザメ，アカエイ等の血清を添加しても最大波長に殆んど変化がみられない．

次に congo red と血清の混液について求めた吸収曲線を Fig. 8 図に示した．

congo red の blank では最大波長が 495 mμ 附近にあるが，これに供試血清を添加しても最大波長に殆んど変化がみられない．

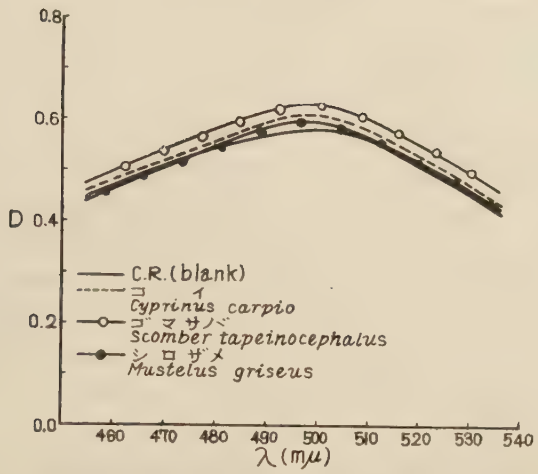


Fig. 8.
Absorption spectra of congo red solution in serum of fishes.

The serum-dye mixture consisted of 0.1 ml. of 0.01% congo red, 2.0 ml. of M./15 phosphate buffer solution (pH 7.3), and 0.2 ml. of serum.

即ち，これらの色素では bromophenol blue の場合にみられた様な metachromasis における顕著な種属的差異は認められなかつた．尤も methylene blue の場合は一色性の色素であるから，これが当然の結果とも考えられる．

考　　察

以上の実験結果より，血清蛋白質と色素の結合性にみられる種属的差異は，実験材料間の血清蛋白質組成の差異に由来すると推察されるので，両者の関係について若干の考察を試みた．

Klotz 氏等の報告[1]によると，15 種の球状蛋白質の中で，pH 7 附近で cation 色素と結合したものは殆んどなく，また methyl orange と結合したものは血清 albumin と β-lactoglobulin のみで，血清 globulin 等は結合しないとのことである．本実験でも血清 albumin（牛血製）は methyl orange（anion）と明らかに結合するのに対し methylene blue（cation）との結合は殆んど認められなかつた．これらの事実より，Fig. 1〔A〕に示したウシの血清蛋白質の結合曲線には，それに含まれる血清 albumin（総蛋白質量の約 50% を占める）が支配的に関係していることは確かである．また methyl orange とかなりの結合量を示した供試硬骨魚類の血清蛋白質にも albumin 区分の存在することは既に確認[2,3]しているが，methyl orange との結合が明らかでない供試軟骨魚類の血清蛋白質には，前報[2,3]で述べた如く albumin 区分が認められないことは注目に値する．これらの血清蛋白質でも，これに精製 albumin 或は albumin 区分を含む血清蛋白質を添加するとかなりの結合量を示す事実や，前述の Klotz 氏等[1]の結果等よりしても同魚類の血清蛋白質と methyl orange との結合性にみられ特異性は，その血清蛋白質に albumin 区分を欠いている事実に由来する現象と解される．このことは特に Fig. 5 の実験結果より立証される．

次に本報の実験結果によれば，血清蛋白質と色素イオンとの結合性にみられる種属的差異は，何れも anion 色素である methyl orange と bromophenol blue の場合に認められた．一般に血清蛋白質と色素イオンが結合するためには，蛋白分子内に対応するイオン基の存在を必要とするが，只存在するというだけでは不充分で，そのイオン基は色素イオンが近づき得るような位置にあり，且つ分子内結合等でしばられていない自由にイオン化出

来る基でなければならない．このようなイオン化基は蛋白分子中で最も反応性に富んだ基であつて，蛋白質の機能に大きな影響を与えるものであるところに，この反応のもつ重要な意義がある．前述の如く Klotz 氏等[1]の試みた約 15 種の球状蛋白質では，7 に近い pH で，cation 色素と結合したものは殆んどないのであるが，この現象に対して同氏等は用いた蛋白質の分子内の OH 基が酸性アミノ酸残基の COO^- と特に強い水素結合を造るためではないかと想像している．供試魚の血清蛋白質でも種類の如何を問わず cation 色素と結合し難いことが認められたことより，その分子内には色素イオンに近づき易いイオン化した anion 基量の極めて少ない事は推察し得る．また anion 色素である methyl orange の場合，血清 albumin はかなりの結合量を示すのに対し同じく球状蛋白質でありながら γ-globulin は結合しないのである．この現象は γ-globuin では分子中に hydroxyamino 酸残基が多いので cation 基は OH 基と分子内結合を起しているのに対し albumin では分子中に OH 基より cation 基がかなり多いため anion 色素と顕著に結合すると考えられる[1]．魚類の血清蛋白質のアミノ酸残基の組成は不明であるから詳細な考察は出来ないが，本実験の結果より，軟骨魚類は血清中に albumin 区分を欠き硬骨魚類よりも血清蛋白質の分子中におけるイオン化した cation 基量，即ち反応性に富む基の量が著しく少ないという種属特異性のあることは諒解される．それにも拘らず軟骨魚類は硬骨魚類に優るとも劣らぬ活発な生活現象を営んでいることは比較生化学的にも興味深い問題を提示しているようである．

摘　　要

拾数種の魚類について血清蛋白質と methyl orange (anion 色素)，bromophenol blue (anion 色素) 及び methylene blue (cation 色素) 等との結合性を所定条件下の平衡透析法，電気泳動法及び吸収波長測定法により検討し，硬骨魚類と軟骨魚類とでは血清蛋白質と anion 色素との結合体にかなり種属特異性のあることを明らかにした．

I) 硬骨魚類に属する供試魚の血清蛋白質は対照動物（人間，家兎及びウシ）の場合と同様に methyl orange と顕著な結合を示すのに対し軟骨魚類に属するものでは両者の結合が明らかでなかつた．一方 methylene blue に対しては，各試料共に結合量は極めて少なく，methyl orange の場合にみられたような明確な種属的差異は認められなかつた．これらの事実より硬骨魚類と軟骨魚類とでは血清蛋白質分子中のイオン化した cation 基量にかなり相異のあることが諒解される．

methyl orange の単位血清蛋白質量当りの結合量は供試魚が対照動物の場合より一般に少なく，また硬骨魚類に属するものでも魚種により若干の差のあることを認めた．

II) 血清と bromophenol blue 混液の泳動図を求めたところ，対照動物と硬骨魚類の場合は bromophenol blue（紫色）と albumin 区分の結合した泳動峰（青色）が認められたのに対し，軟骨魚類の場合は，この泳動峰がみられなかつた．即ち対照動物と硬骨魚類の血清では albumin 区分に対する bromophenol blue の結合と，それに伴う metachromasis が認められるが軟骨魚類に属する供試魚の血清ではこの現象が全く認められなかつた．この事実からも軟骨魚類の血清蛋白質は albumin 区分を欠いていることが諒解された．

III) 血清または血清蛋白質と bromophenol blue 混液の吸収曲線を求めたところ，軟骨魚類に属する供試魚では bromophenol blue の blank と同様に約 595 mμ に最大吸収波長

が認められるのに対し，対照動物と硬骨魚類の場合は最大吸収波長が約 605 mμ に変化し，metachromasis が明らかにみられた．bromophenol blue の代りに，methylene blue 或は congo red を用いた場合は各試料共に最大吸収波長の変化が殆んどみられなかつた．

以上述べた如く硬骨魚類と軟骨魚類とでは血清蛋白質と anion 色素との結合性に顕著な種属的差異のあることを認めたが，これは両魚類間における血清蛋白質組成の差異，特に軟骨魚類の血清にはイオン化した cation 基量に富む albumin 区分が認められないという事実に起因すると各種の実験結果より推定した．

終りに本研究を行うに当り，北海道大学中村幸彦教授並に文献を御教示下さつた東海区水産研究所大竹茂夫技官に深謝する．また本研究費の一部は文部省科学研究費の支出に仰いだ．記して謝意を表する．

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船内氷蔵の効果向上に関する基礎試験–I*

魚艙の細菌汚染の実態と市販殺菌灯の使用効果について

鮫島宗雄・斎藤　要

Improvement in Efficiency of Icing of the Catch in a Fishing Boat — I

The Bacterial Contamination in a Fish Hold and the Sterilizing Effect of a germicidal Lamp

Muneo Sameshima and Kaname Saitō

Abstract

Some foundamental researchs upon bacterial contamination of wooden fishing boats (less than 100 tons) were carried out and the effect of a germicidal lamp upon the sterilization of bacteria was studied.

1) The bacterial densities were examined in several parts of the fishing boats, which had been throughly washed after unloading of the catch. And, in the fish hold, which has been most frequently in contact with the catch, the density was counted more than 10^6 per cm.^{2}.

2) The bacterial density calculation shows the existance of a close relationship between the efficiency of washing and the wall materials or wall paints of the fish hold. The material which shows the best effect is a galvanized iron, the second best is the one coated with vinyl chloride paint or coal tar, while, in case of plain wooden wall, the effect could be barely observed.

3) The installation of a germicidal lamp in the fish hold was proved to be very effective in sterilizing the bacteria on the wall. This result probably be attributable to the fact that most of the bacteria in the fish hold consist of non-sporing species which have weak resisting capacity to the ultra violet ray.

緒　　言

冷凍設備を有しない小型漁船は漁獲物の保蔵手段として氷蔵法を用いている．その保蔵効果の向上は業界の要望であり，薬剤氷例えば次亜塩素酸ソーダ[1]，フラスキン（5–nitro–2–furfuralsemicarbazone）[2]，Zフラン（5–nitro–2–furylacrylamide）[2]或いはオーレオマイシン（chlortetracycline）[2,3,4,5,6]含有氷についてはかなり研究されている．しかし，保蔵効果をさらに向上するには，基礎試験として漁船特に魚艙の細菌汚染の実態を調査する必要がある．しかしこれに関する研究は少なくCastell 氏等[7,8]のトロール漁船の魚艙内の細菌汚染調査の報文を見る程度である．著者等はこの目的をもつて魚艙並びに漁獲物保蔵用の氷について細菌の分布を検討したが，その結果，魚艙及び保蔵用の氷の細菌数の消長より見た魚艙の洗滌効果は，壁面の材質と密接な関係のあることを認め，さらに魚艙内での市販殺菌灯の使用は，細菌汚染の防除手段として極めて有効であることを知つた．

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* 本報告は 1958 年 4 月日本水産学会年次大会（東京）で発表した．

実 験 の 部

1. 調査の対象と期間

鹿児島市中央市場に水揚げを行う 100 t 以下の冷凍設備を有しない木造漁船を対象とし，昭和 32 年 5 月から翌年 3 月に至るまで調査を行つた．これらの漁船は，主としてサバ一本釣，瀬物延縄船である．また氷については漁船に積込まれる直前のものと，使用後のものを試料とした．

2. 細菌数の算定と表示法

細菌数の算定は壁面についてはふきとり法[10,11]により採菌し，1 cm² 当りの細菌数を以て表した．氷については溶解後常法により 1 ml 中の細菌数を求めた．

実験結果及び考察

1. 船体各部の細菌汚染状況

漁獲物を貯蔵する魚艙について詳細な調査を行う先立つて，その他の二三の船体部位との細菌汚染状況の比較を行つた．その他の部位としては漁獲操作の行われる前甲板の舷側及びブリッジ側壁を選んだが，細菌数は Table 1 の如く，cm² 当りブリッジでは大略 10^4，舷側では 10^5 台であるのに対し，魚艙は各船とも 10^6 以上であつた．予想通り漁獲物と直接接触する機会が多く汚れやすい部位ほど細菌数の多いことが諒解される．

Table 1. Bacterial number of the various parts of the fishing boat.

Ship's name	Bacterial number (10^3/cm.²)		
	Wall of the fish hold	Side of the quarter deck	Outside wall of the bridge
Nichinan Maru	6,200	—	40
No. 5 Nissho Maru	5,800	—	6
Koei Maru	6,600	—	3
No. 3 Kyowa Maru	7,100	—	6
No. 2 Koei Maru	2,000	—	10
Fukuei Maru	1,900	—	8
No. 6 Nanshin Maru	5,700	530	9
Kyoshin Maru	3,400	560	6
Hoyo Maru	5,300	320	18
Ryuho Maru	3,800	750	7
No. 2 Taisho Maru	5,300	580	5

Inspection was carried out after washing of the deck and the hold.

2. 魚艙壁の塗装状況と細菌汚染の関係

魚艙の構造と配置は各船とも，ほぼ同様であるが，内壁の塗装には若干の種類が見受けられた．塗料としてはミツイライト（塩化ビニール系塗料），コールタール，ペンキが用いられており，トタン張りも数隻あつたが大多数は無塗装のままであつた．市場に水揚げをすませた漁船は直ちに魚艙及び甲板等の洗滌を行うが，Table 2 は魚艙内壁の塗装，或は材質が洗滌効果に及ぼす影響を細菌数の消長よりしらべたものである．即ち，水揚直後の洗滌前に魚艙の内壁の所定位置より，洗滌後その隣接位置よりそれぞれ採菌し，両者の細菌数を比較したものである．勿論この結果には魚艙への漁獲物の収納量或は収納期間の影響も考慮しなければならない．本表は塗装別に数例ずつあげたがそれぞれの間に判然とした細菌数の差異が表われている．先ず，洗滌前の細菌数を比較すると無塗装とコールタール塗装の壁面の多くは 5,000 万個/cm² 以上であつたのに対し，塩化ビニール塗装とトタン

Table 2. Decrease in number of bacteria on the wall of the fiish hold through washing, classified according to types of the wall.

Ship's name	Part in the hold	Bacterial number (10^3/cm.^{2}) Before washing	After washing	Survival rate of bacteria (%)
Plain wooden wall				
No. 2 Kyoei Maru	Upper	36,000	20,000	56
	Middle	18,000	11,000	61
	Lower	84,000	71,000	85
No. 3 Kyowa Maru	Middle	10,000	7,100	71
Hoyo Maru	Middle	6,200	5,300	85
Coated with coal tar				
Sen'ei Maru	Upper	1,600	600	38
	Middle	56,000	3,700	7
	Lower	22,000	2,800	13
Chidori Maru	Upper	70,000	4,500	6
	Middle	6,300	2,700	43
	Lower	7,600	2,100	28
Chidori Maru	Upper	4,800	1,200	25
	Middle	5,700	1,500	27
	Lower	2,600	1,200	46
No. 2 Kowa Maru	Middle	7,600	2,000	26
Fukuei Maru	Middle	8,300	1,900	23
Coated with vinyl chloride				
Gyoho Maru	Upper	3,400	480	14
	Lower	3,600	700	19
Suzu Maru	Upper	5,100	380	8
	Middle	2,900	770	24
	Lower	10,000	800	8
Galvanized iron wall				
No. 1 Masa Maru	Middle	13,000	30	0.2
No. 8 Taga Maru	Upper	2,600	70	3
	Lower	4,900	180	4

Washing was done immediately after unloading of the catch.

張り壁面からは 5,000 万個/cm^2 以下の検出例が多かつた．洗滌後の細菌残存数より見ると最も洗滌効果のあがつたものはトタン張り魚艙で，洗滌前 1,000 万個以上あつたものが簡単な洗滌操作で 3 万個まで減少した例もあつた．細菌の残存率は数字的にばらつきが多いが一応比較の資料とすると，これについては，塩化ビニール塗装とコールタール塗装が細菌数の減少からは同じ程度に良好であつたが，細菌の附着数からみれば前者の方が良い材質と言える．しかし無塗装の壁面では，元来細菌附着数も多い上，洗滌効果も少くなく大半は洗い去ることが出来ない有様である．

この結果は単に細菌数の問題に止まらず一般的な魚艙不潔の度合として比較し得る数字と言えるであろう．これと別の面から，魚艙内の位置による細菌数の差異を上部，中部及び下部について数例しらべたが，確然たる結果は得られなかつた．すでに Castell 氏等[9]もトロール漁船の木製魚艙においては，多少の洗滌を行つても細菌数を減少させるには効果のないことを報告している．

小型漁船の細菌汚染を少くするためには種々の対策を考えなければならないが，現実には無塗装の魚艙を持つものが過半数であり漁獲物は水氷の中で運ばれる場合が多いため，細菌は魚艙のすみずみまで広がり容易に細菌数を減少さることはできない．また市場からの廃水が混つた海水を洗滌に使用している事実をしばしば見受けたが，これでは逆効果となる恐れがある．細菌汚染度を低下させるためには，先ず魚艙の壁面に撥水性の塗装或は資材を使用し洗滌方法を改善する必要がある．

3. 操業前後における魚艙の細菌数

操業によつて変化する魚艙の細菌数を，鹿児島県水産試験場の調査船ちどり丸を使用して調査した．本船は約1カ月の休漁の後8日間の瀬物延縄を行つたが，出漁前と帰港後の魚艙壁の細菌数を算定した結果は Table 3 に示す通りである．2個の魚艙について調査したが，それぞれ壁面の上・中・下部の3部について操業前後，同じ場所から採菌したものである．

Table 3. Bacterial number on the wall of a fish hold before and after fishing operation.

Part in the hold	Bacterial number (10^3/cm.^{2})					
	Hold A			Hold B		
	Upper	Middle	Lower	Upper	Middle	Lower
Before fishing	3,300	4,000	3,800	400	1,400	1,800
After unloading before washing	70,000	6,300	7,600	4,800	5,700	2,600
after washing	4,500	2,700	2,100	1,200	1,500	1,200

In this boat, the Chidori Maru, the hold, which is coated with coal tar, had not been used for about a month before the fishing operation.

これより1回の操業によつて魚艙の細菌が著しく増加すること，洗滌直後の残存細菌数は1カ月余りの休漁期間ではあまり変化しないことが考えられる．

以上の諸実験と併行して，保蔵のために使用され且つ魚艙内で最も魚と接触する氷についてもその細菌数を算定した．

Table 4 は操業前の漁船に積込まれる直前の氷と，水揚げ時の使用済み氷に附着する細菌数である．

Table 4. Bacterial number in surface layer of ice for storage during the use (per 1 cc.).

Before the use	Immediatly after the unloading of the catch	
1,200～3,600	(No. 2 Taisho Maru)	3,400,000～7,200,000
	(No. 2 Kyoei Maru)	4,100,000～6,000,000
	(Sen'ei Maru)	670,000～4,100,000

この結果は，氷は使用中に著しく細菌汚染を受けることを示しており，氷或いは小型漁船でよく用いられる水氷は細菌の担体となり易く，使用済み氷の再使用などは避けなければならないことが諒解される．

4. 魚艙内における殺菌灯の使用効果

以上の諸実験により魚艙の細菌汚染は非常に高いことを知つた．このような魚艙内での氷蔵は，薬剤氷等の使用により保蔵効果の向上をはかるとともに，魚艙内壁の細菌汚染防除にも留意すべきである．前述の如く壁面の細菌数は簡単な洗滌のみによつては容易に減

少させることはできないが，われわれは一つの試みとして魚艙内に殺菌灯をとりつけ，その照射による壁面の殺菌効果を検討した．

照射実験は鹿児島県水産試験場の調査船照南丸の2個の魚艙で行つた．この2個の魚艙はほぼ同形で，おのおのの中央部に 15 W 殺菌灯（ナショナル GL-15）1灯をとりつけたが，艙内及びとりつけ使置は Fig. 1 の通りである． 照射距離は 60 cm と 120 cm の2種を選んだが，壁面の殺菌効果は Fig. 2 に示す如くである．なお両魚艙とも塩化ビニール塗料で

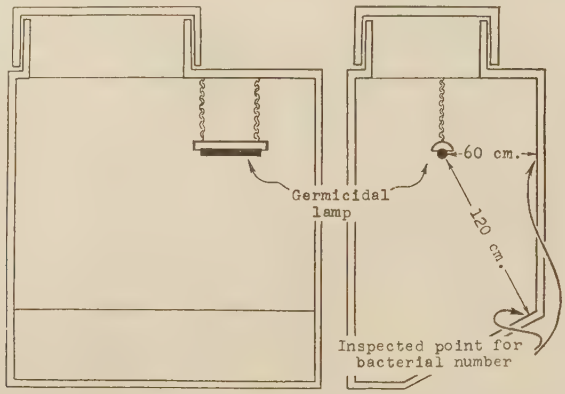

Fig. 1. Inside sketch of the fish hold in the Shonan Maru and situation of a germicidal lamp.

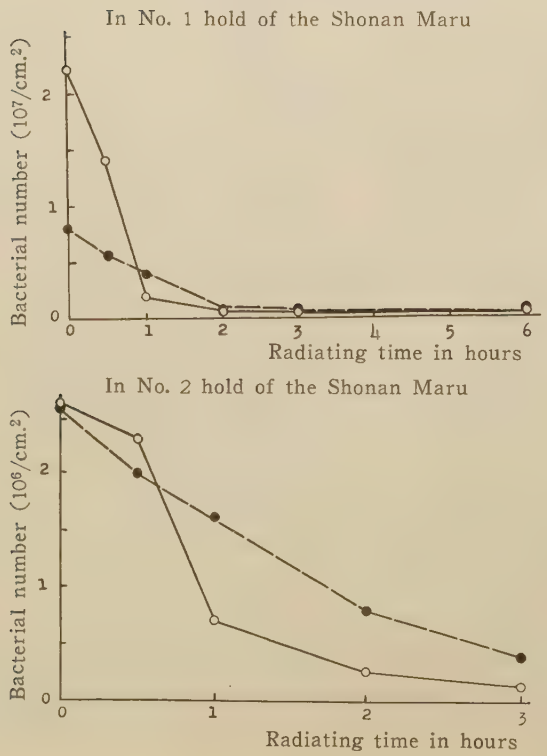
In No. 1 hold of the Shonan Maru
Bacterial number (10⁷/cm.²)
Radiating time in hours
In No. 2 hold of the Shonan Maru
Bacterial number (10⁶/cm.²)
Radiating time in hours

Fig. 2.

Sterilizing effect of ultra violet ray on the wall of the fish hold

Ultra violet ray was radiated from a 15 W. germicidal lamp situated 60 or 120 cm. (showed by ○ and ● in the figures respectively) apart from the fishhold wall.

塗装されていたが，第1の魚艙には塗料のない個所が数カ所あり，上図の照射距離 60 cm の位置もその一部である．

紫外線の殺菌効果は近来各方面で認められ応用されているが[12]，本実験においても，壁面塗料の有無にかかわらずかなり表われた．無塗装の個所は最初の細菌数は多かつたが，照射 1 ～ 2 時間後には急激に減少し塗装した個所と殆んど同程度になつた．照射距離の影響は 60 cm，120 cm の間には大差なく，効果はさらに遠くに及ぶことが想像されるが，本実験の条件下では約 3 時間が最も経済的な照射時間と考えられる．

このような殺菌灯の効果は，魚艙に附着する細菌の殆んどが紫外線に抵抗力の弱い無芽胞菌であることも原因の一つと考えられ，また空気中の細菌に対しては壁面に対する以上の効果を挙げ得るはずである．各種薬剤を使用する化学的な殺菌法に較べても操作は簡単且つ経済的であることより，使用方法に一層の工夫を加えると漁獲物の鮮度保持，食品衛生の見地からも実用性のあるものと思われる．この研究にあたり種々御助力を賜わつた上田忠男氏等鹿児島県水産試験場の皆様に深謝する．

要　　約

100 t 以下の小型木造船の魚艙内壁における細菌分布状況を調査するとともに，殺菌灯を魚艙内の細菌を減少させる目的で使用し，次の結果を得た．

1) 漁獲物の水揚げ，魚艙及び甲板の洗滌をすませた漁船の各部位における細菌の分布をしらべたところ，漁獲物に接触する機会の少ないブリッジ側壁では cm^2 当り大約 10^4 個，漁獲と水揚げ操作の行われる前甲板部の舷は 10^5 個台の細菌数を示したのに対し，魚艙内壁からは各船とも 10^6 個以上が検出された．

2) 魚艙内壁に用いられた資材または塗料の種類により，水揚げ直後に行われる洗滌の効果にかなりの差があることを知つた．細菌数の減少度から見ればトタン張りの魚艙が最も良く，次いで塩化ビニール塗装，コールタール塗装の順であり，無塗装の木製魚艙では洗滌の効果が殆んど表われなかつた．

3) 魚艙内において殺菌灯を使用することは，魚艙壁面の細菌数を減少させる上に極めて効果的であり，15 W 管で 60～120 cm の照射距離では約 3 時間が最も経済的な照射時間であることを知つた．このような効果には魚艙内に見出される細菌の殆んどすべてが，紫外線に対して抵抗力の弱い無芽胞菌であることも一因をなしていると考えられる．

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カツオ幽門垂のビタミンB群に関する研究—III

ビタミン B_6 について

柿本大壱

Studies on B-Vitamins of Pyloric Coeca of Skipjack (*Katsuwonus vagans*)—III

on Vitamin B_6

Daiichi KAKIMOTO

Abstract

1. Content of vitamin B_6 in the pyloric coeca of skipjack was studied by bioassay. *L. casei* and *S. faecalis* were used for the determination of pyridoxal and pyridoxamine respectively.

2. Basal medium of the bioassay contains vitamin-free casein hydrolysate. The latter was prepared from commercial casein hydrolysate by a newly-devised method, that is, by oxidation of the hydrolysate with $KClO_3$. The vitamins which are contained in the commercial casein hydrolysate are completly broken down by oxidation with $KClO_3$, although certain kinds of amino acids are also decomposed (Table 4). A perfect basal medium can be prepared by supplement of the decomposed amino acids to the medium with oxidized casein hydrolysate (Table 4).

3. Pyridoxal and pyridoxamine content in the pyloric coeca is 1.35 and 0.88 γ per one gram of dry matter respectively. Presence of pyridoxine was not detected (Table 7). The determination was made on fresh material.

4. A piece of proposed evidence shows that pyridoxal in the pyloric coeca is transformed partly into pyridoxamine when the dissected-out organ has been stored at -4°c for one month (Table 6).

前報[1,2]に引続きカツオ幽門垂に含まれているビタミン含量を明らかにすのため B_6 の定量を行つた．又 B_6 の定量に関しては従来の方法を一部変えて定量を容易にした．多くのBビタミンと同様 B_6 の定量は Bioassay によるのが普通である．ピリドキサール，ピリドキサミン，ピリドキシンの如く構造類似化合物の総和を定量する Atkin ら[3]の方法や，各個の B_6 を2種類以上の異なつた菌によつて定量する別な方法もある．例えばピリドキサミンは *S. faecalis* によつて定量されるが，この菌はピリドキサールとピリドキサミンに対し同等の response を示すことが知られているので，ピリドキサミンを定量するには同一試料でピリドキサールを *L. casei* によつて定量し，前記 *S. faecalis* の定量値からこの値を引き去つて算出する．又ピリドキシンは *Neurospora sitophyla* によつて単独に定量し得るが，この方法は菌体重量を一々天秤によつて正確に秤らねばならないので繁雑であり，更に培養時間も他の方法よりも長いので不便である．著者は同一試料を *Saccharomyces carlsbergensis* によつて B_6 の総和を測り，*S. faecalis* によるピリドキサール，ピリドキサミン量を引き去つてピリドキシンを定量した．B_6 の定量に用いる基礎培地中，アミノ酸類には B_6 不含カゼイン水解物を使用することになつているが，我国では目下のところこれに適した商品が見当らないので，市販カゼインから B_6 を除去して用いなければならない．著者は定量に先だち B_6 不含カゼイン水解物の調製について研究し，併せて幽門垂中の B_6 含

量を定量した.

実験及び結果

1. ピリドキサール

ピリドキサールは *L. casei* により Rabinowitz, Snell[4] らの方法で定量した.

i) ピリドキサール不含カゼイン水解物の調製：ピリドキサールの定量に用いるカゼイン水解物は酸加水分解液とトリプシン消化により分解したものを等量混合して調製する. この両混合液から B_6 を除去するにはフラー土，或いは Darco-G 60 等の吸着剤によるのが普通である. 著者はこれらの吸着によらず，わが国で容易に入手し得る酸性白土を用いて吸着除去することに成功した. カゼイン水解物は次のような方法で作つた，すなわち市販カゼインを 20% の塩酸で 16～20 時間煮沸分解し，減圧下で蒸発を繰返えし大部分の塩酸を除去する. 水解物中他の一つであるトリプシン消化液は同じカゼイン 1 g に N/10 苛性ソーダ 20 cc を加え湯煎上で溶解してから 15 ポンド 30 分間加圧加熱し，冷却後希塩酸で pH を 8.2 とし，これにパンクレアチン 1 g を加えトルオールで防腐しつつ 37°C, 24 時間消化して作つた. なお消化液中には菌の発育に影響を与える脂肪類もあるので消化後 30 分間煮沸し酵素作用を止めた後 pH を 4.0 に調整し，エーテル，トルオール (10 : 3) を加えて充分振盪し約 3 時間後に分液漏斗で溶媒を除去し，水解液中に残存する溶媒をも除去して作つた. 両カゼイン水解液を等量混和したものは，その中からピリドキサールを酸性白土によつて除去してから基礎培地に使用した.

ii) 酸性白土の活性化：市販の酸性白土をそのまま使用するとピリドキサールの除去は不完全であり基礎培地としては使用出来ないので，次に述べる処理法で活性度を高めて使用した.

A. 酸性白土を坩堝中で還元焔により約 3 時間焼いた.

B. 酸性白土を蒸溜水で充分洗滌してから A と同様にして焼いた.

C. 酸性白土 30 g を 2% の酢酸 100 cc. に浸漬し，約 1 時間振盪後濾過し，蒸溜水で充分洗滌してから 150°C の空気浴中で 4～6 時間乾燥し粉末にした.

iii) カゼイン水解物からピリドキサールの除去：前記 3 種類の処理法で得た酸性白土 15 g はカゼイン水解物（カゼイン 1 g に相当する溶液）の pH を 1.0 に調整したものに加え，約 3 時間振盪した後濾過し，使用した酸性白土は充分水洗して濾液と合せる. 次にこの溶液の pH を 6.8 に調整し全容を 50 cc にする. 以上の如くして得たカゼイン水解物中にピリドキサールが残存するか否かを確めるため，カゼイン水解物を含まぬ Rabinowitz らの培地と合せ全容を 100 cc となし，この溶液を試験液に *L. casei* による Bioassay を行つた. なお比較検討するために 10 mγ のピリドキサールを加えたものも使用した. 培養条件は 30°C, 24 時間で，測定は濁度法によつた. Table 1 はその結果である. すなわちカゼイン水解物中のピリドキサールの除去は前記何れの方法でも良いが，このうち還元焔で焼いた酸性白土を用いた場合が 120°C で乾燥したものに比較し良好であることは，10 mγ のピリドキサールを補足した培地に於ける菌の繁殖の度合からみて明らかである. 以上の如くカゼイン水解物からピリドキサールを除去するには，操作も簡単な還元焔で 3 時間焼いた酸性白土によるのが望ましい. なおこの他酸性白土の使用法，吸着時の pH 条件等も吟味したが，前記の如くカゼイン 1 g 相当の水解物に 15 g, pH は 1.0 が最も良好な結果を示した，次に若しピリドキサールを除去する際にカゼイン水解物中のアミノ酸類が同時

Table 1. The responses of *L. casei* to pyridoxal which may be contained in casein hydrolysate treated with Japanese acid clay.

Type of treatment of Japanese acid clay before addition to casein hydrolysate	The responses of *L. casei* to pyridoxal in casein hydrolysate Turbidometric measurement (T%)	
	With 10 mγ of pyridoxal	Without pyridoxal
Burned with reducing flame for 3 hrs	45	96
After treatment with 2% acetic acid, the acid clay was dried for 4 hrs. at 120°C	68	97
After washing with distilled water, the acid clay was burned with reducing flame for 3 hrs	43	96
Control. Not-treated casein hydrolysate	21	25

Table 2. Adsorption of pyridoxal, but not of amino acids, in casein hydrolysate by Japanese acid clay treatment

Types of basal medium		Responses of *L. casei* Turbidometric measurement (T%)	
		With 10 mγ of pyridoxal	Without pyridoxal
Basal medium, not supplemented		42	96
Basal medium +L. Aspartic acid	0.5 mg	43	96
〃 +L. Glutamic acid	0.5 mg	42	97
〃 +DL. Methionine	0.5 mg	42	96
〃 +DL. Phenyl alanine	0.5 mg	42	96
〃 +L. Tyrosine	0.5 mg	41	95
〃 +L. Histidine	0.5 mg	42	96
〃 +L. Leucine	0.5 mg	42	96
〃 +DL. Isoleucine	0.5 mg	42	95
〃 +L. Arginine	0.5 mg	42	97
〃 +Serine	0.5 mg	42	96
〃 +DL. Valine	0.5 mg	41	96
〃 +all Above amino acids		42	96

に失われることがあるとすれば，基礎培地としては不完全になる．依つて *L. casei* に不可欠のアミノ酸を補足し，菌の発育に対するアミノ酸の影響をしらべた． Table 2 はその結果である． これをみると著者の考案した酸性白土法はアミノ酸を補足する必要がなく，従来使用したフラー土と同様に使用出来ることを知つた．

iv) 標準曲線の作成：前項の実験結果に従いピリドキサール不含カゼイン水解物を調製し基礎培地に加えた．基礎培地組成は Rabinowitz らのものを用い標準曲線はピリドキサールを 0.5, 1.0, 1.5, 2.0, 2.5 mγ 加えた培地によつて作成した． Fig. 1 の標準曲線は *L. casei* の 30°C, 24時間培養の結果で示したものである．

v) 試料の調製：天然物中のピリドキサ

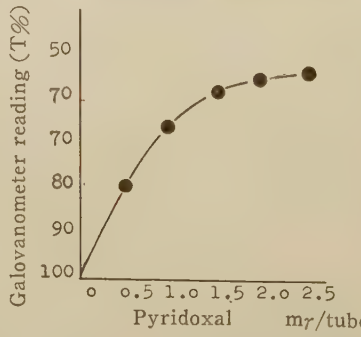

Fig. 1. Response of *L. casei* to pyridoxal. *L. casei* was incubated at 30°C for 24 hrs.

ールは全てが遊離型とは限らないので定量にあたつて，酸又はアルカリにより結合型は全て遊離型にして定量した．すなわち幽門垂 5 g に塩酸を加え pH を 1.8 にした後全容を約 180 cc とし，20 ポンドで 5 時間加圧加熱してから蒸溜水を加えて 500 cc に稀釈して定量を行つた．又遊離法の別法として同一試料に 1 N 苛性ソーダ 10 cc を加え，前と同様加圧加熱し塩酸で中和後 500 cc に稀釈したものについても測定した．Table 3 はその結果を示したものである．表で示したように試料の前処理によつて幾分定量値に相違があり，酸処理法が高い値を示したが，回収率からみて酸処理法が信頼のおける結果である．すなわちカツオ幽門垂中のピリドキサール含量は乾物 1 g 中約 1250 mγ であつた．

Table 3. Pyridoxal content in the pyloric coeca of skipjack.

Concentration of sample	Content in a tube (mγ)	Content in one gram of fresh matter (mγ)	Content in one gram of dry matter (mγ)	Recovery (%)
Acid-treated sample				
1/500	0.41	205	1025	92
Alkali-treated sample				
1/500	0.50	250	1250	98

2. ピリドキサミン

ピリドキサミンもピリドキサールと同様に Rabinowitz, Snell らの方法が広く用いられている．氏らによると菌は *S. faecalis* であり，この菌はピリドキサミンとピリドキサールに対し同等の response を示すので，ピリドキサミンのみを定量するにはあらかじめピリドキサールの含有量を *L. casei* で測定しておき，*S. faecalis* による値からこれを引き去る方法による．*S. faecalis* によるピリドキサール，ピリドキサミンの総和を測定するにあたり，ピリドキサールの場合と同様に基礎培地に用いるカゼイン水解物からピリドキサミン並にピリドキサールを除去しなければならない．このことにつき諸種の実験を繰返えしたが，カゼイン水解物を塩素酸カリで酸化する方法を考案したので，その成績を述べる．

i) ピリドキサミン不含カゼイン水解物の調製：カゼイン分解物はピリドキサールの項で述べたと同様にして作り，その pH を 3.5 に調整した．次にカゼイン 1 gに相当する水解物に塩素酸カリ 0.05 g を加え，酸化に要する時間を決めるため各々 20, 30, 60 及び 120 分煮沸分解し，各分解時間の異なる試料につきピリドキサミンが除去されたか否かを試験した．試験法はピリドキサールの場合と同じように酸化を行つたカゼイン水解物とそれを含まない Rabinowitz らの培地を合せ，これに *S. faecalis* を移植し，30°C, 72 時間培養，菌が生産する酸をアルカリで滴定しその量によつてカゼイン水解物中に残存するピリドキサミンの量とした．然しながら塩素酸カリによる酸化が若し水解物中のアミノ酸を同時に酸化し，*S. faecalis* に不可欠のアミノ酸を失うとすれば，カゼイン水解物中にピリドキサミンが残つていても菌は繁殖出来ないので，各培地にアミノ酸を補足しピリドキサミンが酸化で失われることを確めると同時に，アミノ酸類の帰趨をしらべた．Table 4 は実験結果である．この実験によるとピリドキサミンの酸化時間は 60 分で完全に行われるが，これと同時にチロジン，メチオニン，ロイシン以上 3 種類のアミノ酸も失われる．従

Table 4. Responses of *S. faecalis* to pyridoxamine and amino acids, in case of supplying the amino acids to the casein hydrolysate oxidized with $KClO_3$.

Supplemented amino acids. mg per tube (final volumes are 2 cc.)		Supplemented pyridoxamine mγ per tube	Responses of *S. faecalis* N/20 NaOH (cc.) 0*	I*	II*	III*	IV*
None supplied		10	2.4	2.0	0.4	0.2	0.2
		0	2.0	1.8	0.4	0.2	0.2
L. Arginine	0.5	10	2.3	2.0	0.4	0.2	0.2
		0	2.0	1.7	0.4	0.2	0.2
DL. Leucine	0.5	10	2.4	2.1	0.6	0.6	0.3
		0	1.9	1.7	0.4	0.2	0.2
DL. Isoleucine	0.5	10	2.4	1.9	0.4	0.2	0.2
		0	2.0	1.7	0.4	0.2	0.2
L. Glutamic acid	0.5	10	2.3	1.9	0.4	0.2	0.2
		0	1.9	1.8	0.3	0.2	0.2
L. Histidine	0.5	10	2.4	1.9	0.4	0.2	0.2
		0	2.0	1.7	0.4	0.2	0.2
L. Lysine	0.5	10	2.4	2.0	0.3	0.2	0.2
		0	1.9	1.8	0.4	0.2	0.2
DL. Methionine	0.5	10	2.3	2.2	0.8	0.7	0.4
		0	1.8	1.7	0.4	0.2	0.2
DL. Threonine	0.5	10	2.4	2.0	0.4	0.2	0.2
		0	2.0	1.8	0.4	0.2	0,2
L. Tyrosine	0.5	10	2.3	2.3	0.9	0.9	0.5
		0	1.9	1.7	0.4	0.2	0.2
DL. Valine	0.5	10	2.5	2.0	0.4	0.2	0.2
		0	2.0	1.8	0.4	0.2	0.2
L. Tyrosine, DL. Methionine, DL. Leucine	each 0.5	10	2.4	2.3	2.0	2.0	1.8
		0	2.0	1.8	0.5	0.2	0.2
Above noted all amino acids	each 0.5	10	2.5	2.4	2.0	2.0	2.0
		0	2.0	2.0	0.5	0.2	0.2

* Casein hydrolysates was oxidized by following methods
0 : Not-treated with $KClO_3$, I : Treated with $KClO_3$ at pH 3.5 for 20 mins, II : Treated with $KClO_3$ at pH 3.5 for 30 mins, III : Tteated with $KClO_3$ at pH 3.5 for 60 mins, IV : Treated with $KClO_3$ at pH 3.5 for 120 mins.

つてこのカゼイン水解物を基礎培地に使用するには上記3種類のアミノ酸を補足する必要がある.

ii) *S. faecalis* の発育に及ぼす KCl の影響：塩素酸カリを pH 3.5 で作用させるとカゼイン水解物中のピリドキサミンは酸化されるが，自らは KCl に変化する．従つてこの水解物を用いて基礎培地を作成すれば，培地中に KCl が含まれることになる．細菌類は塩類の或る濃度で発育が阻害されることが知られているので，この点も明らかにする必要がある．前述の如くカゼイン水解物を酸化するに要する $KClO_3$ の量は 1 g相当の水解物に 0.05 g であり，酸化後基礎培地を調製する場合 100 cc に稀釈されるので，仮りに $KClO_3$ のままで計算しても基礎培地中では 0.05% に相当する．今 10 mγ のピリドキサミンを含む培地に $KClO_3$ を 0.01 から 2.0% になるように培地を作り，*S. faecalis* を植えてその繁殖をしらべてみたが，Table 5 に示す如く，0.7% 以下の濃度の場合には何らその影響を認めなかつた．従つて著者がピリドキサミン酸化に用いた $KClO_3$ の量はこの assay には阻害を及ぼさないと判断される．

Table 5. Inhibition by KCl of the growth of *S. faecalis*.

Amount of KCl added to basal medium containing 10 mγ of pyridoxamine (%)	Growth of *S. faecalis* N/20 NaOH (cc.)
0	2.4
0.01	2.46
0.05	2.40
0.1	2.60
0.3	2.40
0.5	2.40
0.7	2.40
0.9	1.94
1.0	1.60
2.0	0.90

iii) 標準曲線の作成：標準曲線の作成にあたり接種菌の濃度及び培養温度とその時間を規制する必要がある．*S. faecalis* によるピリドキサミンの定量には通常 30°C，20～24 時間が採用され，測定は濁度法による．著者が新に作成した基礎培地について二三試験した結

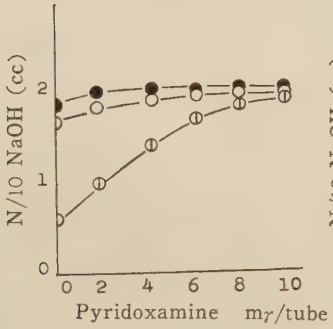

Fig. 2. Responses of *S. faecalis* to pyridoxamine. Inoculum is not diluted.

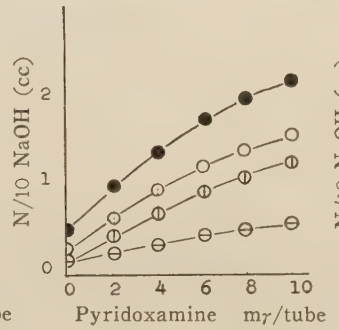

Fig. 3. Responses of *S. faecalis* to pyridoxamine. Inoculum is diluted 50 times.

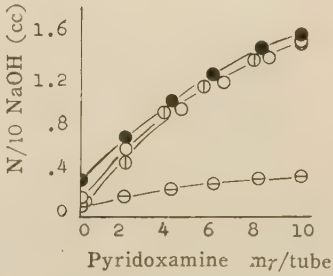

Fig. 4. Responses of *S. faecalis* to pyridoxamine. Inoculum is diluted 100 times.

—●— Growth of *S. faecalis* incubated at 30°C for 72 hrs.
—○— Growth of *S. faecalis* incubated at 30°C for 48 hrs.
—◑— Growth of *S. faecalis* incubated at 30°C for 24 hrs.
—⊖— Growth of *S. faecalis* incubated at 30°C for 18 hrs.

果では，濁度法による場合既往の条件と一致する他，30°C，48 時間の培養法では酸度滴定でも定量出来ることを知つた．又この場合の接種菌の濃度は 100 倍稀釈のものが適する（Fig. 2, 3, 4, 5 参照）．カゼイン水解物の塩素酸カリ処理法はピリドキサミンの定量のみならず，前述の *L. casei* によるピリドキサール及び *Sac. carlsbergensis* による全 B_6 定量にも応用出来る．今その一例として *L. casei* によるピリドキサールの定量に於ける標準曲線を作る場合，酸

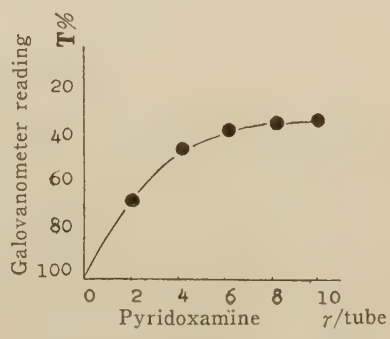

Fig. 5. Response of *S. faecalis* to pyridoxamine. Inoculum is diluted 100 times *S. faecalis* was incubated at 30°C for 18 hrs.

性白土処理のカゼイン水解物を使用した場合と比較した結果は Fig. 6 の通りであり，ほぼ同一の Response curve が得られることを知つた．

iv) 幽門垂中のピリドキサミン含量：試料幽門垂は枕崎市に陸揚げされた新鮮なものを用い，この 1 g に 0.055 N の塩酸 180 cc を加え，20 ポンド 5 時間加圧加熱して，試料中のピリドキサミンを遊離させた後，*S. faecalis* による定量を行つた．Table 6 は幽門垂中のピリドキサミン量を示したものである．なおこの実験には特に新鮮な幽門垂を用いた以外に，これを −4°C の冷蔵庫に 1 カ月間貯蔵し，それによつて幽門垂中の B_6 が如何に変化するかを検べた．又蛋白質分解の要領で加水分解した幽門垂中の B_6 についても試験した．その結果 1 カ月間貯蔵した場合にピリドキサールは減少するが，それとほぼ同量のピリドキサミンが増加している結果を得た．又酸加水分解によるとピリドキサールの一部はピリドキサミンに変化するが，この場合 B_6 量が分解前に比べ可成り減少することを確めた．

Table 6. Content of pyridoxamine in the pyloric coeca.

Samples	Content in one gram of dry matter		
	Apparent value by *S. faecalis* (A) (γ)	Pyridoxal by *L. casei* (B) (γ)	Pyridoxamine (A)−(B) (γ)
Fresh pyloric coeca	2.23	1.35	0.88
Pyloric coeca stored at −4°C for one month	2.12	0.90	1.22
Fresh pyloric coeca acid-hydrolyzed	1.86	0.84	1.02

v) ピリドキシン：ピリドキシンは *Neurospore sitophyla* によつて単独に定量されるが，著者は *Sac. carlsbergensis* により全 B_6 を定量し，前述の *S. faecalis* による値を引き去る方法により定量した．Table 7 はその結果を示したものであり，幽門垂中には殆んどピリドキシンが含まれていないことを知つた．

Table 7. Pyridoxine content in the fresh pyloric coeca

Content in one gram of dry matter		
Total B_6 by Sac. carlsbergensis (A) (γ)	Pyridoxal and pyridoxamine (B) (γ)	Pyridoxine (A)−(B) (γ)
2.26	2.27	0

摘　　要

幽門垂中の B_6 を Bioassay で測定し次の結果を得た．

1. ピリドキサールは *L. casei*，ピリドキサミンは *S. faecalis* と *L. casei* の両菌により，ピリドキシンは *Sac. carlsbergensis* と *S. faecalis* 両菌により定量した．これらの定量にあたり，基礎培地に用いる B_6 不含のカゼイン水解物を著者の創意により調製した．すなわちカゼイン水解物を塩素酸カリによつて酸化し，これに二三のアミノ酸を補足することにより定量し得ることを明らかにした．

2. 新鮮なるカツオ幽門垂中には乾物 1 g 中，ピリドキサールが 1.35 γ，ピリドキサミンが 0.88 γ 含まれ，貯蔵中にピリドキサールの一部がピリドキサミンに変化することを知つ

た．又ピリドキシンはこの器官には含まれていない．

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Slip Motion of a Projectile Striking a Water Surface, I

Tikao HUZITA

Abstract

A survey of the photographs taken with both a 35 mm camera and an 8 mm cine camera, reveals that there are two kinds of slip motion. (1) After striking the water surface, the projectile slides along the water surface sending up a spray, and after a while it falls down. (2) After striking the water surface, the trajectory of the projectile in the air seems to be extended into the water. And an instant later the course in the water curves upwards, and the projectile reaches the surface but it does not fly off the water. So, the projectile moves along just beneath the surface for some time and then falls down.

In the former case, the major axis of the projectile does not coincide with the tangent of trajectory of the projectile but is horizontal or close to the horizontal. And in the latter case, the major axis of the projectile coincides with the tangent of the trajectory. So, this case is considered to be the critical case of the ricochet.

1. Introduction

The studies of ricochet motion of a bullet, a sphere and a harpoon were carried out by Isobe[1], by Ramsauer[2] and by Hirata[3] respectively. And the force of impact of a projectile striking a water surface at a right angle[4] or an arbitrary angle[5] has been reported. The motion of a projectile with head-cone or a harpoon was also investigated by the author[6].[7] [8].

The projectile ricochets if its incident angle is smaller than the critical incident angle. The ricochet motion was analyzed[7] introducing the following non-dimensional coefficients: coefficient of retardation $e_x=1-(v_2\cos\alpha_2/v_1\cos\alpha_1)$, coefficient of ricochet $e_y=v_2\sin\alpha_2/v_1\sin\alpha_1$, and coefficient of slip $e_s=s_2/d$ (Fig. 1). The critical incident angle between ricochet and swimming for any projectiles obtained from the experiment is considered to be the critical angle coresponding to the critical conditions $e_x=0$, $e_y=1$. Therefore, if these conditions are satisfied, it is expected that the motion which resembles the slip of a projectile striking the smooth wall will appear.

In the present paper the author's intention is to make clear the slip motion which will appear at the critical incident angle between ricochet and swimming.

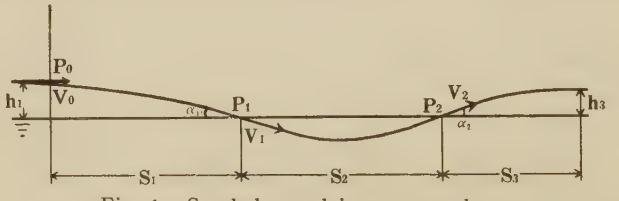

Fig. 1. Symbols used in e_x, e_y and e_s.

2. Experiment and Result

1) To investigate the slip on the water surface, four types of projectiles, each apex angle of which measures 180°, 90°, 60° or 30°, are projected horizontally with the velocity of 4.6 ~ 4.9 m/sec on the water surface. The dimensions of the projectile are as follows—diameter: 15 mm, full length: about 62 mm, weight: about 28 g, tail: 4 plates.

The course of the projectile is intermittently illuminated with an intensely bright

multi-stroboscope newly devised for this experiment and then the projectile in motion, in the air and in the water, is photographed simultaneously with both a 35 mm camera and an 8 mm cine camera.

2) A survey of the photographs reveals that there are two kinds of slip motion. One of them is the following: after striking the water surface, the projectile slides along the water surface sending up a spray. Then it falls down as shown in Fig. 2. Another is the following: after striking the water surface, the trajectory of the projectile in the air seems to be extended into the water. And an instant later the course in the water curves upwards, and the projectile reaches the surface but it does not fly off the water. So, the projectile in the water moves along just beneath the surface for some time and then falls down (Fig. 3).

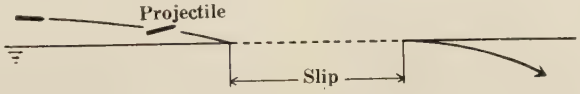

Fig. 2. Slip motion : the major axis of a prjectile does not coincide with the tangent of the trajectory.

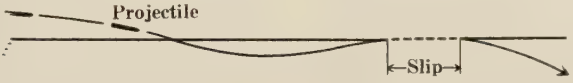

Fig. 3. Slip motion: the major axis of a projectile coincides with the tangent of the trajectory.

In the former case, the major axis of the projectile that slides well like an aquaplane, does not coincide with the tangent of trajectory of the projectile but is horizontal or is close to the horizontal. This motion is similar to the gliding of a seaplane.

And in the latter case, the major axis of the projectile coincides with the tangent of the trajectory. So, this case is considered to be the critical case of the ricochet.

Therefore, the author summarizes the data obtained from the photographs in which the major axis of the projectile coincides with the trajectory, and reports in the present paper the results for the projectile with an apex of 60°.

The results for 180°-, 90°-, and 30°-projectiles will be reported in the next paper.

3) The photograph (Experiment No. 02–35, incident angle 7.3°, incident velocity 4.6 m/sec) taken with a 35 mm camera does not obviously show that the projectile ricochets (Fig. 4), but the consecutive photographs (Fig. 5) taken with an 8 mm cine camera show the projectile in ricochet motion. The coefficients obtained from the consecutive photographs of the projectile are $e_x=0.6$, $e_y=0.9$.

Now, by definition of ricochet coefficient, the case $e_x=0$ seems intuitively to be the boundary between ricochet and swimming. Unexpectedly enough, according to the experiment[3] $e_y=1$ seems to be the boundary between the two motions. The photograph (Experiment No. 02–35) is suitable to observe the transition stage from ricochet to swimming.

4) Next, in the photograph (Experiment No. 03–27, incident angle 8.0°, incident velocity 4.8 m/sec) we can see the slip of the projectile under the water surface (Fig. 6). The projectile projected from a spring gun strikes a water surface, and sends up a spray at the water surface, its path being continued for a while as if its path in the air is extended into the water. Then, the projectile is wholly submerged in the water and at this stage, the air mass follows, especially in the wake of the projectile. As the projectile moves on, the air mass is divided into small bubbles, but its greater bulk

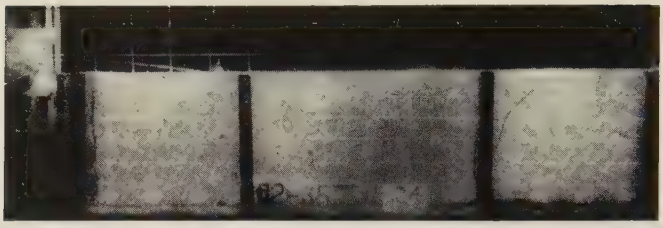

Fig. 4–1. Ricochet motion of a projectile (Experiment No. 02–35).

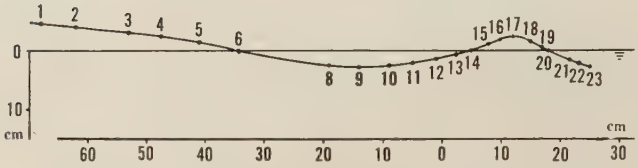

Fig. 4–2. Path of the projectile in the air and in the water (Expeirment No. 02–35).

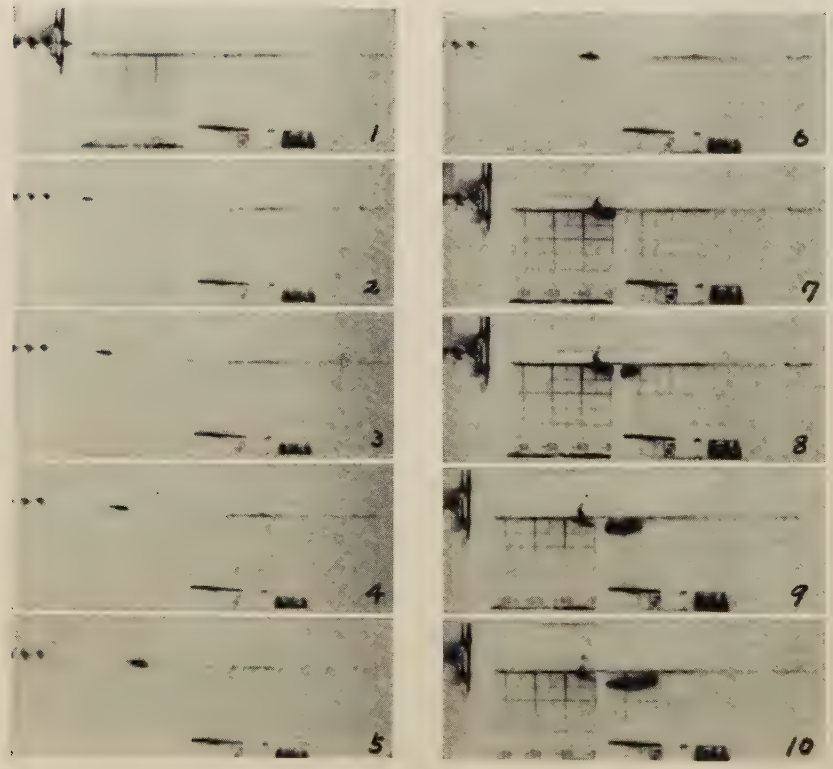

Fig. 5–1~10. Photographs taken with an 8 mm cine camera (Experiment No. 02–35).

Fig. 5-11～28. Photographs taken with an 8 mm cine camera (Experiment No. 02-35).

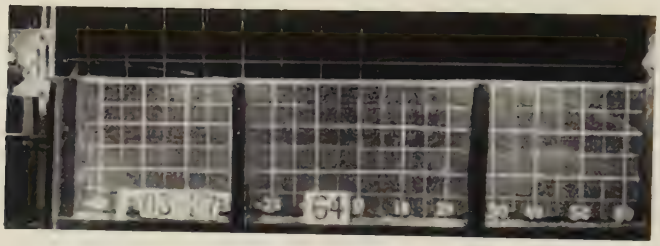

Fig. 6. Slip motion of a projectile (Experiment No. 03-27).

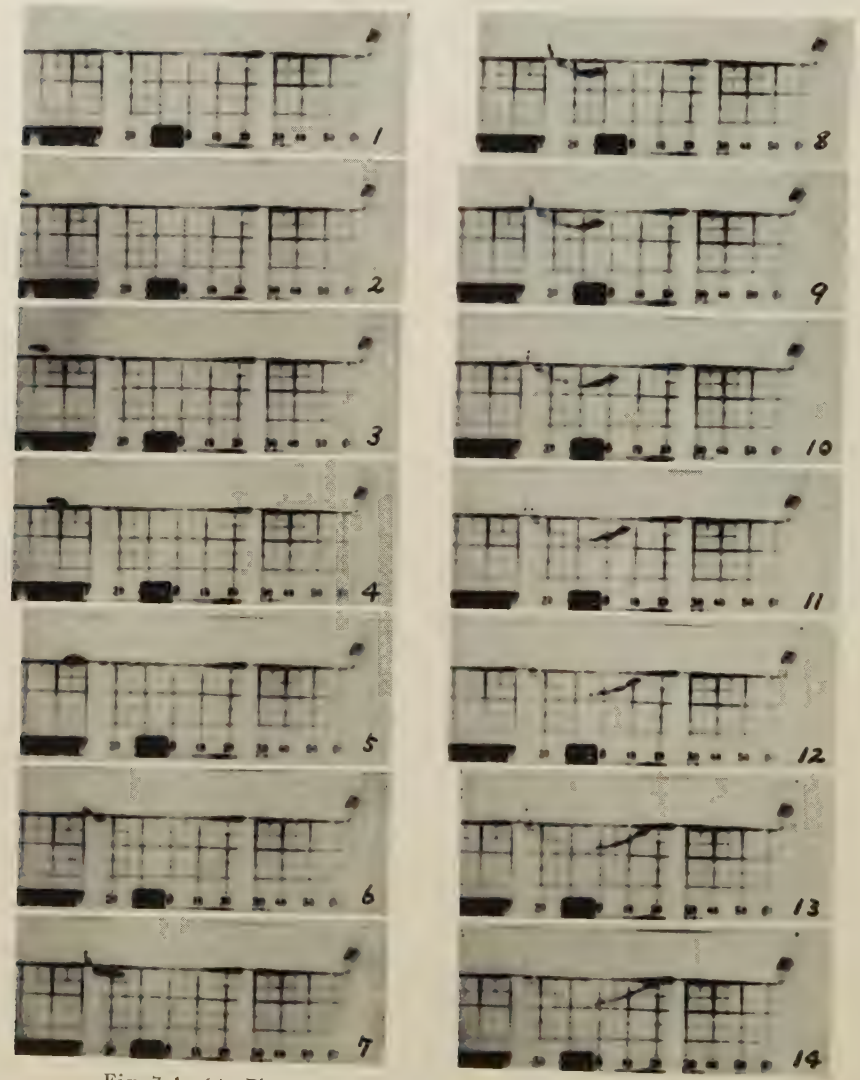

Fig. 7-1~14 Photographs taken with an 8mm cine camera (Experiment No. 03-27).

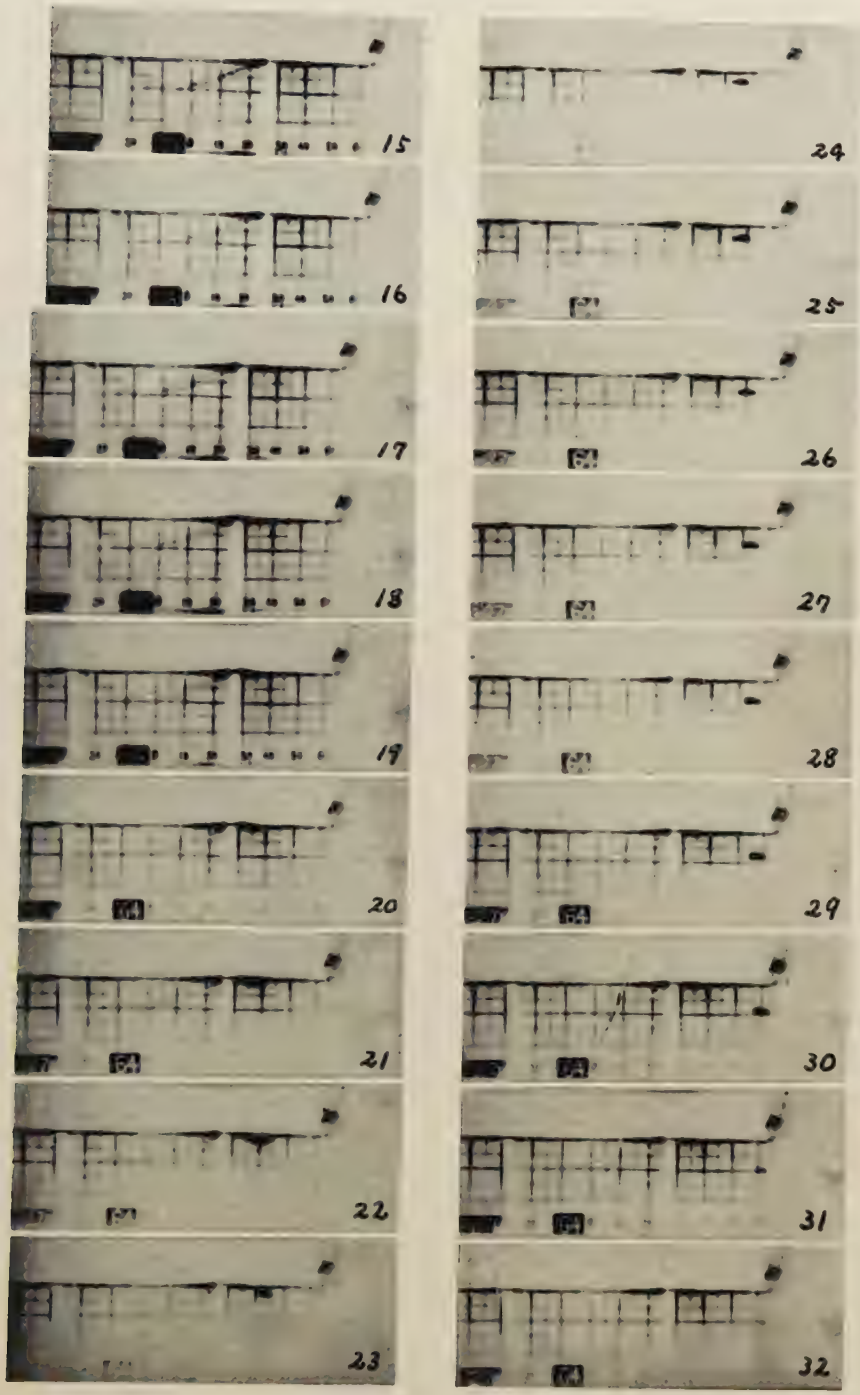

Fig. 7-15～32. Photographs taken with an 8 mm cine camera (Experiment No. 03-27).

remains undivided.

After a while, the direction of the projectile is changed to the horizontal and then upwards. The projectile, then, reaches the water surface, but it does not fly off the water into the air. And so, the projectile rushes along just beneath the water surface, with part of its head-cone appearing above the water surface and ruffling the water. The projectile, finally, directs its head downwards and then falls to the bottom. Although the some bubbles ascend vertically from the beginning of the under-water course until the falling-down course, the projectile is still accompanied with the great bulk of air at the beginning of the falling-down course.

But at the beginning of the falling-down course, the air mass is rapidly seperated from the projectile.

The slip motion mentioned above can easily and clearly be observed in the consecutive photographs of an 8 mm cine camera (Fig. 7). The position of the projectile in the air and in the water, its velocity and accelaration of it are shown in Fig. 8.

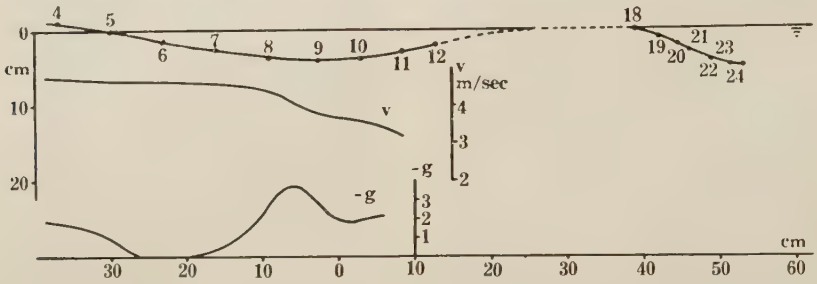

Fig. 8. Path of a projectile in the air and in the water, its velocity and acceleration.

The author wishes to express his sincere thanks to Professor S. Tomotika of Kyoto University for his incessant encouragement and to Professor T. Maekawa of Hiroshima University for his valuable suggections. His thanks are also due to Messrs. M. Nagai, T. Maekawa and S. Namikawa for the trial manufacture of an intensely bright multi-stroboscope. This work was partly financed by the research grant of the Ministry of Education.

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Mixing Stages of Water Masses in the Western Equatorial Pacific

Masaaki CHAEN

Abstract

The mixing stages of water masses in the western Equatorial Pacific are examined by the aid of T–S curves for 370 stations. The original water types related to the region under consideration are determined from materials excluding those of stations in an area between 13°N and 3°S. T–S curves for stations located between 13°N and 3°S can be classified into five groups according to the pattern or mixing stage, corresponding to five geographical divisions nearly parallel to the latitude. The mixing ratio between water types in five divisions are determined. The boundary zone between the water masses from the north and the south is on ca. 6°N, where salinity is roughly homogeneous with depth. The latitudinal change of T–S curves are shown by the aid of average curves for every two degrees of latitude (Fig. 6).

1. Introduction

It is a well-known fact that the three water masses, the western North Pacific Central water mass, the Equatorial Pacific water mass, and the western South Pacific Central watter mass, meet in the western Equatorial Pacific and the mixing stages are complicated. The general feature of the hydrographical conditions in this region is discussed by Takahashi (1959) using materials obtained by the Kagoshima-maru and the Keiten-maru in oceanographic surveys which were performed yearly between 1952 and 1956 including EQUAPAC and IGY projects, but the mixing stages of water masses are not discussed in detail. In past days, the water masses north of the Equator were analyzed by Koenuma (1937) with T–S curves derived from the materials obtained by the Mansyu. In the present paper, the water masses and the pattern of mixing in the western Equatorial Pacific will be discussed by the aid of T–S curves depicted from a number of materials. These materials have been obtained from the expeditions performed by the following vessels: Kagoshima-maru and Keiten-maru of Kagoshima University in 1952–1959: Kosyu, Katuriki, and Komahashi of the Imperial Japanese Navy Hydrographic Department in 1936–1937; Orsom III of the Institut Francais D'Oceanie in 1956–1958; Snellius of the Netherlands Hydrographic Department in 1929–1930. From these surveys, 370 stations are conveniently picked up, as shown in Fig. 1. Making use of these materials, the mixing stages of water masses are examined, although the deep water can not be discussed on account of the shortage of deep water observations.

2. Original Water Types

In the tropical region of the North Pacific, a temperature-salinity curve has an inverted form of the letter 'S' characterized by a salinity maximum at a depth of ca. 100–150 m and a salinity minimum at a depth of ca. 500–600 m; the former corresponds to the upper water and the latter to the subarctic intermediate water. Koenuma (1937) is of the opinion that the origin of the upper water is found on the surface around 20°–30°N and 160°–180°E and that it is transported to Saipan Island area by the northeast trade wind, sinking to ca. 100–150 m due to high density. Among the present selected data, several materials obtained at stations located between 20°N and 13°N are plotted in Fig. 2a & 2b. At a depth of 100–150 m the water around ca. 15°N (Fig.

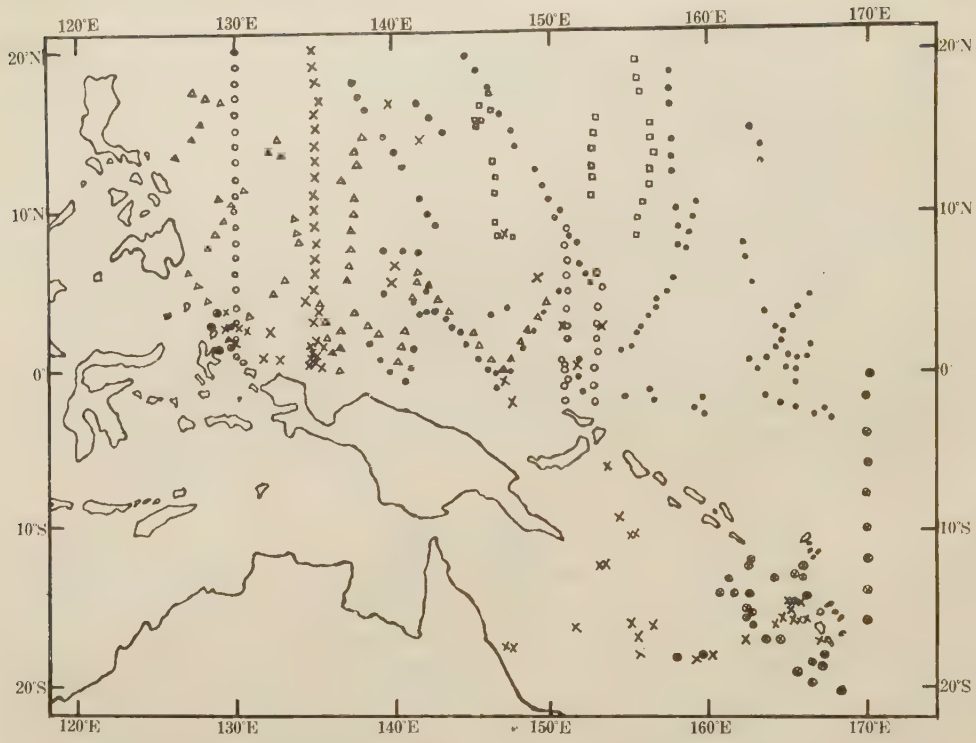

Fig. 1. Map showing the stations. Symbols: circles, Kagoshima-maru; crosses, Keiten-maru; triangles, Katuriki; dots, Kosyu; squares, Komahashi; cirles including crosses, Orsom III; circles including triangles, Snellius.

2a) shows higher maximum of salinity than that around ca. 20°N (Fig. 2b). This fact seems to suggest that the original water type of the salinity maximum is located rather nearer to the former than to the latter on account of the extending direction. As shown in Fig. 2a, the mean values of the temperature, T, and of the salinity, S, of the upper water are ca. 24.6°C and ca. 35.33‰ respectively. On the other hand, the subarctic intermediate water of low salinity sinks at the subarctic convergence and extends toward the south, and the mean values of the temperature and of the salinity of this water are determined from Fig. 2b as ca. 7.0°C and ca. 34.13‰ respectively. According to Koenuma (1937), salinity minimum is found at the layer of ca. 800 m in the water near the Hachijo Island.

In order to discuss the mixing stages of water masses, it is necessary to determine the original values of the water types related to the region under consideration, because a water mass is formed from the mixture of certain water types. The original values of the two above-stated water types can be derived from the character of T–S curves, which have an inverted form of the letter 'S'. Each curve has three nearly straight parts, similar in their pattern. Extending these three straight parts, we can obtain two intersections which show the respective original water types. The procedure is illustrated in Fig. 2a & 2b. The approximate original values of the temperature and the salinity obtained by this procedure are ca. 25.0°C and ca. 35.45‰ in the upper water (Fig. 2a), and ca. 7.0°C and ca. 34.00‰ in the subarctic intermediate water (Fig. 2b). Koe-

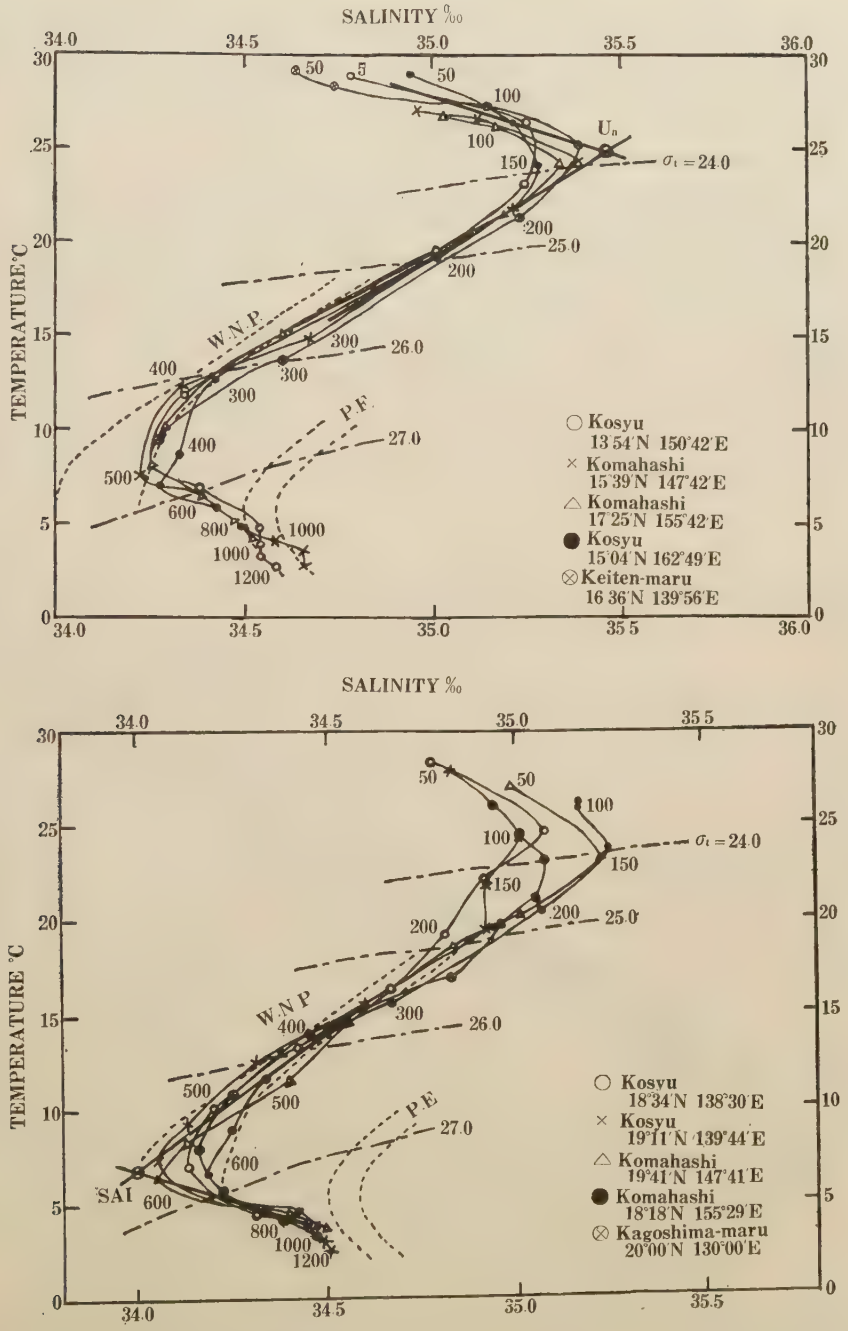

Fig. 2 a, b. Examples of T-S curves in the northern area than 13°N in the western Pacific. Observing depths are entered. W.N.P., western North Pacific Central water mass ; P.E., Pacific Equatorial water mass; these two are shown by Sverdrup, et al. a : upper ; b : lower.

numa (1937) obtained values of T=25.5°C and S=35.50‰ in the upper water, and T=6.5°C and S=34.00‰ in the subarctic intermediate water, from the materials obtained around 15°N for the former and around 20°-30°N for the latter. Coincidence of the values for the low salinity water indicates that the lower water has come from the subarctic water. These upper water and subarctic intermediate water are abbreviated as Un-water and SAI-water hereafter.

In the tropical South Pacific, mainly in the Coral Sea, a temperature-salinity curve has a similar form to that of North Pacific, being characterized by a salinity maximum at a depth of ca. 150 m and a salinity minimum at a depth of ca. 800 m; the former corresponds to the upper water and the latter to the antarctic intermediate water. According to Thomsen (1935), the upper water is found at a layer of ca. 150 m near Tahiti Island, and it may be transported to the western Equatorial region by the South Equatorial current. Among the present selected data, some materials for this region are plotted in Fig. 3. The mean values of the temperature and the salinity of the upper water in this region are ca. 24.0°C and ca. 35.95‰ respectively, whereas those of the antarctic intermediate water ca. 5.6°C and ca. 34.42‰ respectively, as shown in Fig. 3

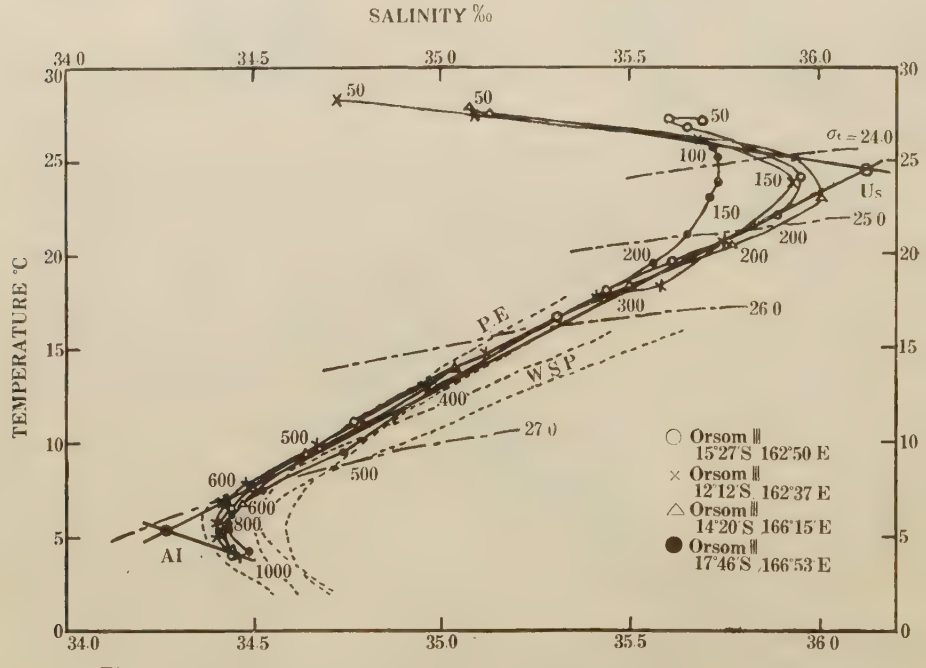

Fig. 3. Examples of T-S curves in the Coral Sea. Observing depths are entered. W.S.P., western South Pacific Central water mass; P.E., Pacific Equatorial water mass; these two are shown by Sverdrup, et al.

The original values of the two water types are determined by the same procedure as before. The procedure is illustrated in Fig. 3. The approximate original values of the temperature and the salinity obtained by this procedure are ca. 24.6°C and ca. 36.13‰ in the upper water, and ca. 5.4°C and ca. 34.27‰ in the antarctic intermediate water. These values farily coincide with Koenuma's values of T=24.4°C and S=36.20‰

in the upper water, derived from the materials obtained by the Planet (Koenuma, 1937), and with Thomsen's values of T=5.2°C and S=34.30‰ in the antarctic intermediate water, derived from the materials obtained by the Dana (Thomsen, 1935). These upper water and antarctic intermediate water are abbreviated as Us-water and AI-water hereafter.

3. Pattern of T–S curves and Mixing Stages of Water Masses

All the present selected data, excepting those treated in the preceding section, are plotted in T–S diagrams. The T–S curves are similar for the stations located within a certain geographical area, and can be classified into five groups, although they have different forms according to the rate of the mixture of the original water types. It is convenient, therefore, to divide the region under consideration into several subregions according to the pattern of the T–S curves in order to study the mixing stages of water masses in a wide extent of the ocean. The boundaries of these subregions are shown in Fig. 4.

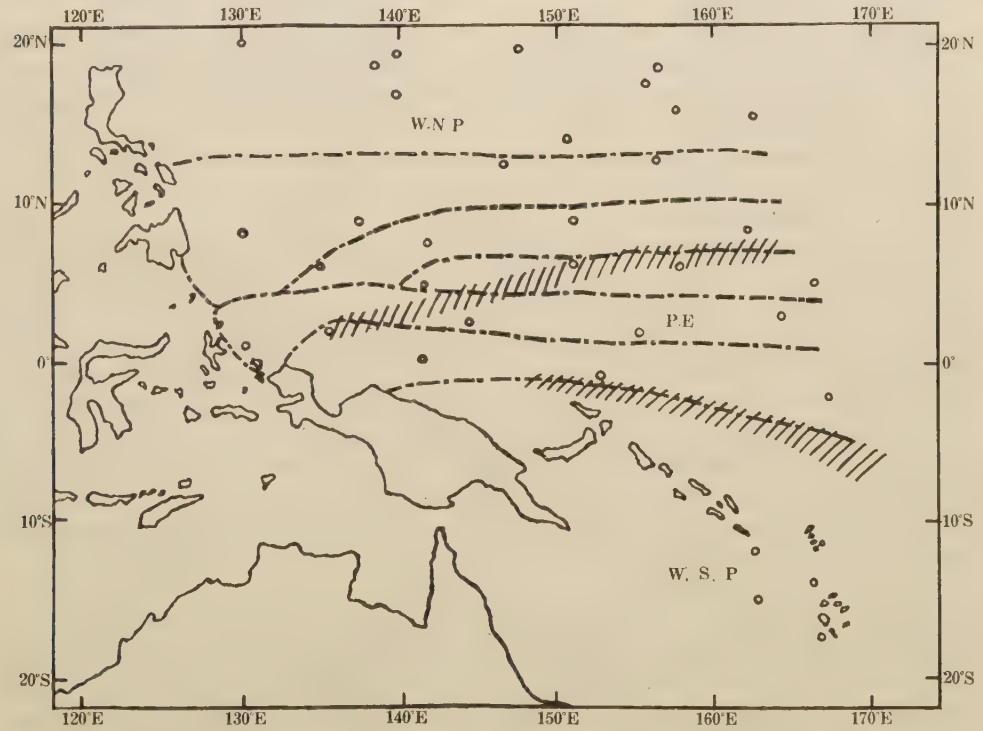

Fig. 4. The boundaries between five geographical divisions corresponding to five groups of T–S curve. Circles indicate the stations used in Figs. 2, 3, 5.

i) The First Group

Examples belonging to this group are shown in Fig. 5a. The region within which the T–S curve belongs to this group is found in a wide region to the east of Mindanao Island extending between 5°N and 12°N, narrowing in the farther east delimited by 13°N and 10°N (see Fig. 4). The Un-water is clearly found at a salinity maximum at ca. 100–150 m and the SAI-water is found at a salinity minimum at ca. 300 m. The latter mixes with the surrounding waters more rapidly than the Un-water. Below

the SAI-water, at a depth of ca. 400–500 m, the second maximum of salinity is found, indicating the incorporation of the water of low temperature and high salinity. According to Koenuma, (1937), the origin of this water of low temperature and high salinity is found in a region north-east of New Zealand and it extends northwestward to the North Pacific below the Us-water. The original values of the temperature and the salinity of this water are 14.0°C and 35.45‰. This water is denoted as the Ws-water. Judging from the T–S curves derived from the materials obtained by the Orsom III in the South Pacific, this water is not found to the south of ca. 6°S along the meridian of 170°E, but it can be found to the north of 5°S on the same meridian. Therefore, its origin must be located far east of 170°E, if this water extends northwestwards across the Equator. The second maximum of salinity at a depth of ca. 400–500 m stated above indicates the mixture of the Ws-water with the AI-water at a rate of 1 : 3 (Fig. 5a). The T–S curves below ca. 400 m in this region coincide with those of the so-called Pacific Equatorial water mass.

ii) The Second Group

Examples belonging to this group are shown in Fig. 5b. This group is found in an area extending east-westerly between 10°N and 7°N, bending south to 5°N to the west of 140°E (see Fig. 4). There is no salinity minimum due to the SAI-water in this region. Below the depth of ca. 200 m, the variation of the salinity with depth is hardly found. The Un-water is still found at ca. 100 m, and the water of ca. 150 m is a mixture of the Un-water and the SAI-water at a rate of 1 : 1.

iii) The Third Group

Examples belonging to this group are shown in Fig. 5c. This group is found in an area delimited by 7°N and 4°N to the east of 140°E, but it is not found to the west of 140°E. (see Fig. 4). The salinity minimum already vanishes in the second group. In this third group, the salinity maximum also disappears. Thus, the variation of salinity with depth is barely found from the surface to the deep layer (ca. 1000 m). Below ca. 300 m, the pattern of the T–S curves are not uniform. This region may be the boundary between the water masses from the north and from the south. The water of ca. 150 m is derived from the mixture of the Un-water and the SAI-water at a rate of 1 : 1. The waters of ca. 200–300 m and ca. 400 m are derived from the mixture of the SAI-water and the Ws-water, and of the Ws-water and the AI-water at a rate of 1 : 1 and 1 : 1.7 respectively.

iv) The Fourth Group

Examples belonging to this group are shown in Fig. 5d. This group is found in an area extending east-westerly between ca. 2°-4°N to the east of 135°E, in the western part it widens southerly to the Equator around 130°E (see Fig. 4). The Us-water characterized by a salinity maximum is found at ca. 150 m. Below this layer the salinity decreases rather sharply, probably under an influence of the SAI-water from the north. The water of ca. 250 m is derived from the mixture of the Us-water with the SAI-water at a rate of 1 : 2. And the water of ca. 300 m and of ca. 400 m are derived from the mixture of the SAI-water and Ws-water, and of the Ws-water and the AI-water at a rate of 1 : 1 and 1 : 2 respectively. The T–S curves below ca. 300 m in this region fairly coincide with those of the so-called Pacific Equatorial water mass.

v) The Fifth Group

Examples belonging to this group are shown in Fig. 5e. This group is found in an area between 1°N and 3°S, but it is not found to the west of 134°E partly delimited by the coast of New Guinea (see Fig. 4). The water between ca. 200m and 300 m are

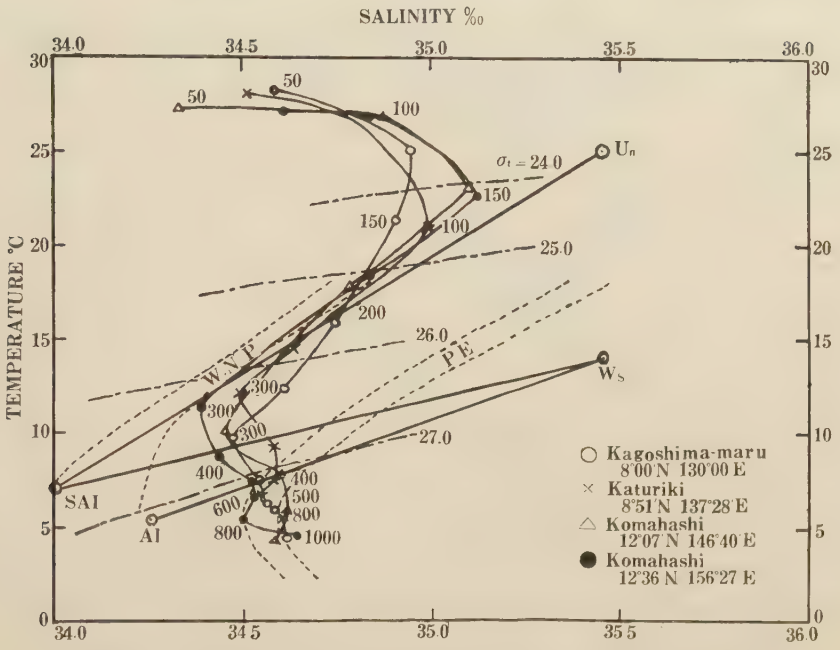

Fig. 5 a. Examples of the first group of T-S curves. Observing depths are enterd. W.N.P., western North Pacific Central water mass ; P.E., Pacific Equatorial water mass.

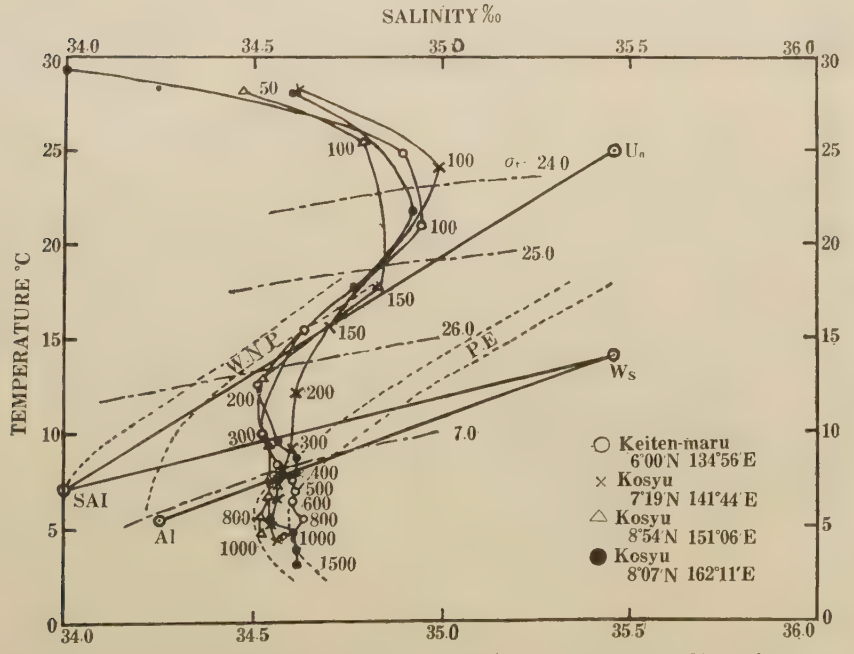

Fig. 5 b. Examples of the second group of T-S curves. Observing depths are entered. W.N.P., western North Pacific Central water mass ; P.E., Pacific Equatorial water mass.

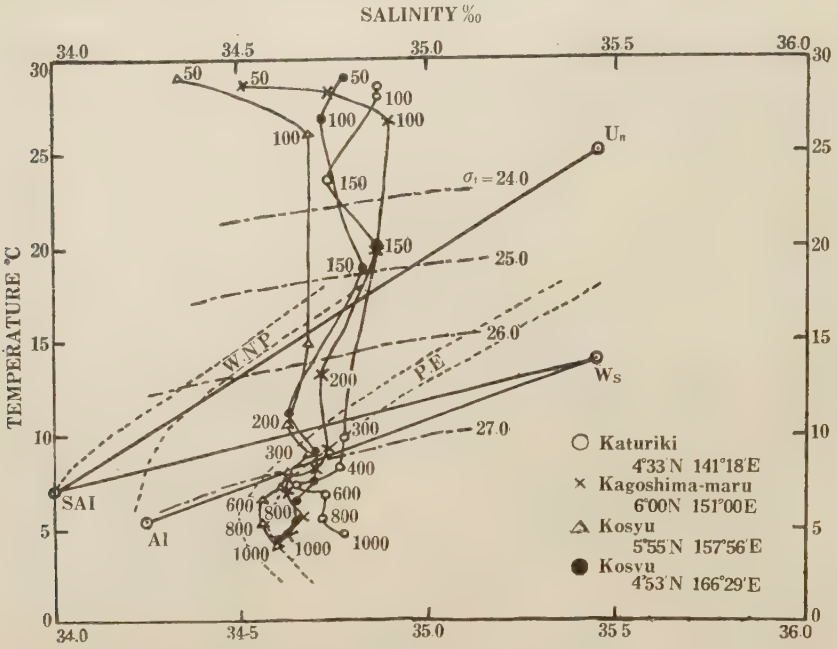

Fig. 5 c. Examples of the third group of T–S curves. Observing depths are entered. W.N.P., western North Pacific Central water mass; P.E., Pacific Equatorial water mass.

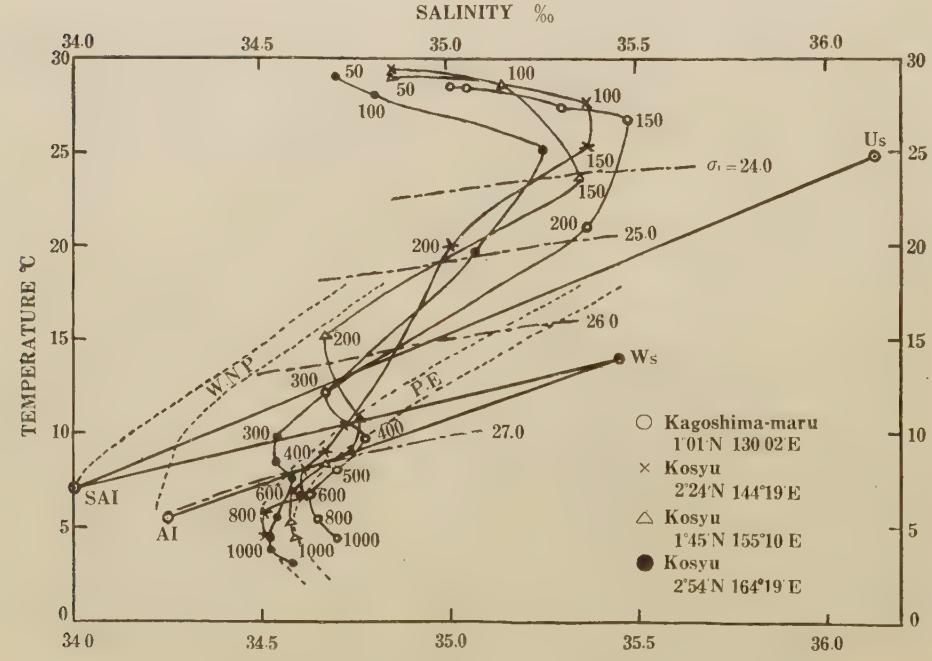

Fig. 5 d. Examples of the fourth group of T–S curves. Observing depths are entered. W.N.P., western North Pacific Central water mass; P.E., Pacific Equatorial water mass.

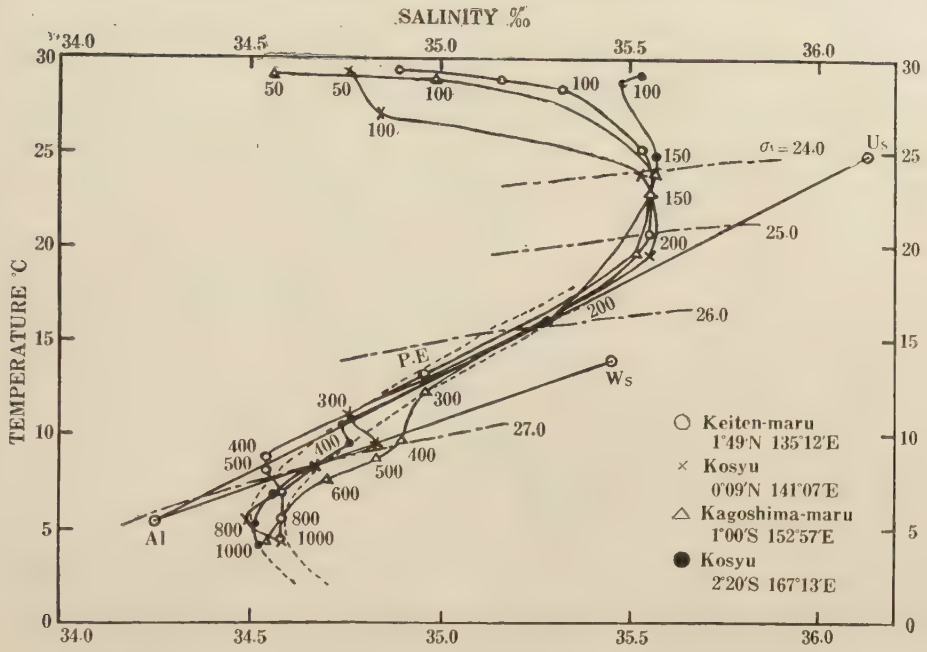

Fig. 5 e. Examples of the fifth group of T–S curves. Observing depths are entered. P.E., Pacific Equatorial water mass.

derived from the mixture of the Us-water and the AI-water. The water of ca. 400–500 m is derived from the mixture of the Ws-water and the AI-water at a rate of 1 : 1.5. The AI-water characterized by a salinity minimum can clearly be found at ca. 800 m. The T–S curves in this region coincide with those of the so-called Pacific Equatorial water mass.

4. Latitudinal Change of Mixing Stage of Water Masses

It may be concluded from the discussion in the previous section that in the western Equatorial Pacific the mixing of water masses advances in the nearly north-south dirction. Accordingly, it is convenient to draw the approximate T–S curves at every latitudes for understanding the mixing processes of water masses. Barnes *et al.* (1948) roughly draw the approximate T–S curves which changes with latitudes, and show the transitional stages between the western North Pacific Central water mass and the Equatorial Pacific water mass. Using the present selected data, the average T–S curves below a depth of 200 m for every two degrees of latitude to the east of 140°E are drawn in Fig. 6. The transitional stages of the mixing process of water masses are seen clearly in the figure. The salinity difference with depth becomes indistinct gradually with latitudes from north to south and it almost vanishes at ca. 6°N (the third group). The temperature of ca. 200 m at this latitude is much lower than that of the surrounding waters. The region around this latitude may be considered as a center of the waters of the North and the South Pacific.

The average T–S curves in the Coral Sea are shown in Fig. 7 for the sake of comparison with those of the above stated waters. The average T–S curve above ca. 500 m in 20°–18°S shows a pattern intermediate between the T–S curves of the Pacific Equatorial water mass and that of the western South Pacific Central water mass, wher-

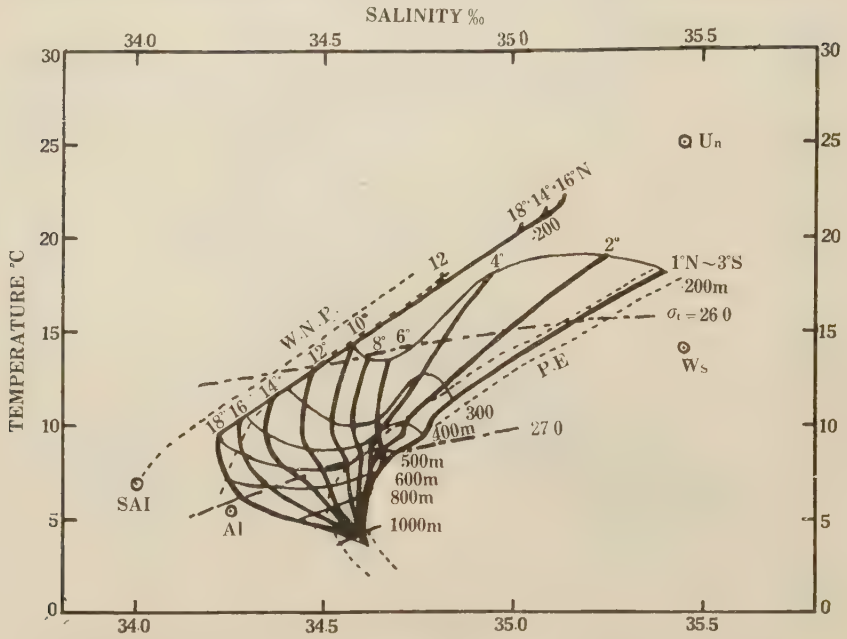

Fig. 6. Average T–S curves for every two degrees of latitude in the area between 18°N and 3°S to the east of 140° E. W.N.P., western North Pacific Central water mass; P.E., Pacific Equatorial mater mass.

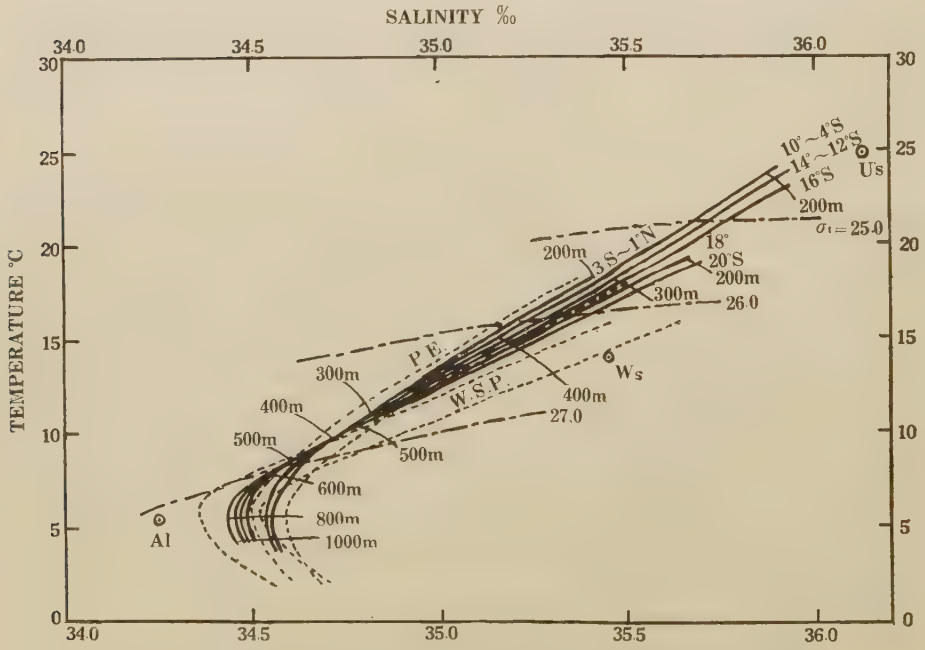

Fig. 7. Average T–S curves in the Coral Sea. W.S.P., western South Pacific Central water mass; P.E., Pacific Equatorial water mass.

eas below ca. 500 m it coincides with that of the western South Pacific Central water mass. When the water mass extends toward the north, the T–S curve above 500 m approaches to that of the Pacific Equatorial water mass, but below ca. 500 m it still keeps the pattern peculiar to the western South Pacific Central water mass. However, the T–S curve at 10°S both above and below 500 m coincides with that of the Equatorial Pacific water mass and this situation continues as far as 4°S. Between 3°S and 1°N the water is much lower in both temperature and salinity than the southern water.

5. Conclusion

370 observations are employed for the study on the mixing stages of water masses in the western Equatorial Pacific. Original water types are determined from materials excluding those of stations in an area between 13°N and 3°S and the results are as follows: northern upper water (Un), T=25.0°C and S=35.45‰; subarctic intermediate water (SAI), T=7.0°C and S=34.00‰; southern upper water (Us), T=24.6°C and S=36.13‰; antarctic intermediate water (AI), T=5.4°C and S=34.27‰.

T–S curves for stations located between 13°N and 3°S can be classified into five groups according to the pattern of T–S curve or mixing stage, corresponding to five zonal divisions nearly parallel to the latitude. In the first group of T–S curve, the salinity maximum of the Un-water at ca. 100–150 m and the salinity minimum of the SAI-water at ca. 300 m are found. Below the SAI-water, the second maximum of salinity due to Ws-water is found at ca. 400–500 m, the mixing ratio between the Ws-water and the AI-water is 1 : 3. In the second group the salinity minimum of the SAI-water almost vanishes and the variation of the salinity with depth is hardly found below a depth of ca. 200 m, although the salinity maximum of the Un-water is still found at ca. 100 m. In the third group the salinity maximum also vanishes. This stage is found around ca. 6°N, which may be considered as the boundary zone between the water masses from the north and from the south. In the fourth group the salinity maximum of Us-water from the south is found at ca. 150 m, while an influence of the SAI-water from the north is found below the Us-water. The ratio of mixture between them is 2 : 1 at ca. 250 m and that between the SAI-water and the Ws-water is 1 : 1 at ca. 300 m. In the fifth group the salinity minimum of the AI-water is found at ca. 800 m. The mixing ratio between the Ws-water and the AI-water is 1 : 1.5 at ca. 400–500 m. The latitudinal change of T–S curves is shown by the aid of average T–S curves for every two degrees of latitude (Fig. 6). For the sake of comparison, average T–S curves in the Coral Sea are also shown (Fig. 7).

Acknowledgement

The auther wishes to express his hearty thanks to Dr. T. Takahashi of Kagoshima University for his kind guidance and encouragement.

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東支那海におけるシロカジキの漁場構成に関する研究—Ⅱ

漁場におけるシロカジキの海洋環境の特徴について

盛　田　友　弌

Fishing-Ground Constitutional Studies on the White Marlin, *Marlina marlina* (JORDAN & HILL), over the East China Sea—II

On the Characteristics of Marine Environments of the White Marlin on the Fishing-Grounds

Tomokazu MORITA

Abstract

In the East China Sea, mutual seasonal changes can be observed between the Kuroshiwo warm current and the coastal water mass (Fig. 1). Hydrographical conditions on the white marlin fishing grounds depend upon the changes of these two water masses. As shown in the charts (Fig. 3-A, B, C & D), the fishing grounds of white marlins roughly coincide with those of mackerels irrespective of the fishing seasons, hence it is to be considered that mackerels play a part as a biological factor for white marlins.

The fishing grounds in winter are formed in the outside vicinity of the cold front (near Lat. 26°N) in the southern part of the East China Sea, while in spring and summer the fishing grounds are found in the outside vicinity of the low-salinity front (near Lat. 29°N) in the eastern part of the East China Sea (Pig. 2). In autumn such frontal areas become undistinguishable and still the fishing grounds of white marlins and those of mackerels are formed overlapping each other (Fig. 3-D), therefore it seems very likely that the formation of the white marlin fishing grounds in autumn depend more on the distribution of mackerels rather than on the hydrographic conditions.

ま え が き

東支那海（東海）におけるシロカジキの漁場構成を考究するには，その漁場海域の海洋学的性格を明らかにする必要がある．

東海には黒潮暖流系水と大陸沿岸系水との性格を全く異にする両系水[1,2]があり，両者の配在を模式的に示せば Fig. 1 のようである．

東海の海況は両系水の相対的な消長に大きく支配されている．ゆえに，南方海域から東海に来遊するシロカジキの漁場構成には，これら両系水の消長が少なからず影響しているようである．

本篇では，前記両系水の消長をその水温と塩素量の分布によつて考え，その時間的，空間的な変化に伴なうシロカジキ漁場の出現状況について考究した．また，東海中央部海域の海洋構造とシロカジキ，サバ漁場との関連性についても検討し，更にこの場合シロカジキの来遊目的がサバ，アジなどを対象とする索餌[3,4]であるとされているので，サバ漁場の介在によるシロカジキの環境構成に関しても併せて考察したのである．

漁場海域の海況変動と漁場構成

東海におけるシロカジキ漁場とその水温，塩素量の分布を Fig. 2 のように緯度別，月別に示した．この水温と漁場の調査資料は 1953～1956 年間におけるものであり，水温は表面水温の月別平均値を用いた．塩素量の調査資料は全域的にきわめて少ないので，関係調査機関* によつて 1954～1957 年間に調べられた資料[5]を総合して用いた．この図によつて，シロカジキの漁場海域における海況の季節的変動に伴なうその漁場の出現状況について考察した．

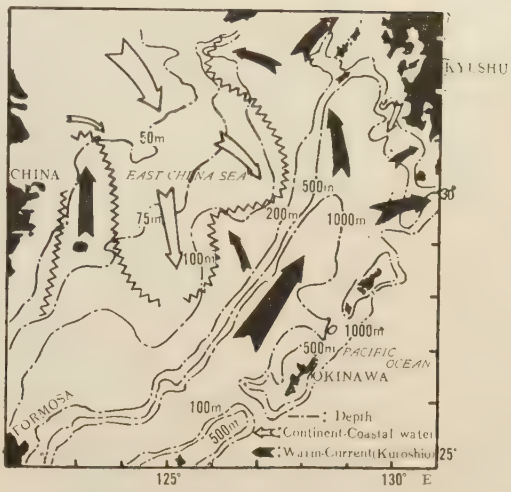


Fig. 1. Schematic chart showing the oceanographic structure of the East China Sea.

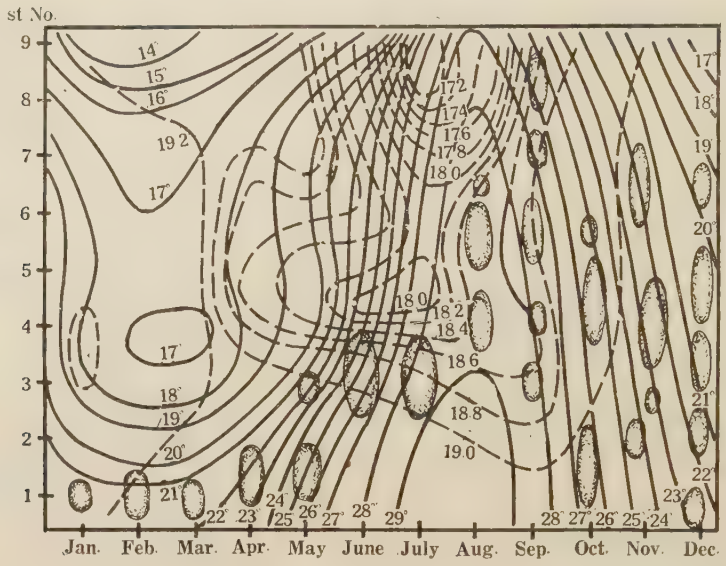
漁場海域の水温は総体的に 2 月最低であり，8 月最高となつている．1～5月間の水温は，27°N 附近でその傾度が激しくなつており，空間的な温度差が大きくなつている．5～7月間の水温は，その初期において北部海域が急速に昇温し，空間的な温度差がきわめて少なくなる．しかし，全域的な昇温が顕著になるので，時間的な温度差が非常に大きくなつている．7～9月間の水温は，その昇温が一時止まり，全域的に最高水温状態を示すようになる．この間の水温変化は時間的，空間的にきわめて少ないのである．9 月以降の水温は，全域的に降温しているが，その温度差は，春季の場合とほぼ同様で，空間的に少なく，時間的に概して顕著になつている．

このような表面水温の時間的変化は主として季節的な気象要因に基いているものと考えられ，この水温変化のみでは前記両系水の相対的消長は余り明らかにされない．

漁場海域の塩分は，冬季に高鹹であり，夏季に低鹹となつており，季節的な差異がきわめて顕著である．すなわち，この海域は 1～2月には全域的に年間における最高の塩素量を示している．4 月頃からはその中央部海域の塩素量が逐次減少し，その後北部海域におよび低鹹となつている．また，この海域は 6～8月間特に低鹹となり，7 月には最低の塩素量を示している．これは，大陸沿岸系水の低鹹水帯が 4 月頃から逐次発達し，漁場海域におよんだものと考えられる．8～9月になるとこの海域は，前記の低鹹水帯が衰退し，再び全域的に高鹹となる．10月以降には漁場の低鹹水帯はほとんど認められなくなり，一方黒潮系の高鹹水帯が全域的に拡張するようになるものと考える．

東海のシロカジキ漁場は，冬季には 26°N 附近の南部海域にのみ出現している．これは，シロカジキが寒冷な前線帯にはばまれて 4 月頃までは全く北上出来ないためであろう．5～7 月の漁場海域は前述のように全域的に昇温するので，寒冷な前線帯は衰退するが，大陸沿岸系水による低鹹な前線帯が漁場中央部の 29°N 附近に出現するようになる．このためこの頃のシロカジキは水温的には一応開放され 29°N 附近まで北上して漁場を構成するが，

* 長崎海洋気象台，長崎県水産試験場，鹿児島県水産試験場，福岡県水産試験場．



: Water-temperature (°C) : Chlorinity (‰)

: White marlin fishing ground

St. No.*	1	2	3	4	5	6	7	8	9
Lat. (N)	26°	27°	28°	29°	30°	31°	32°	33°	34°
Long (E)	123°	124°	125°	126°	127°	127° −30′	127° −30′	127° −30′	127° −30′

* The stations are localized on the white marlin fishing grounds.

Fig. 2. Showing the monthly and spatial variations of water-temperature, chlorinity and fishing positions.

低鹹な前線帯によつてその北上が一時はばまれるようになるものと思考する. しかして, 8～9月に漁場の低鹹水帯がようやく弱勢となり, その水温が最高を示すようになると, シロカジキ漁場は北部海域に出現するようになる. その後漁場海域は更に全域的に高鹹となるが, その水温は概して急激に降下している. このため漁場は南下の傾向を示すようになるが, 12月頃までは漁場海域の大部分がシロカジキの適正水温範囲になつているので, その漁場は南北に広く拡散して形成されるようになるものと考える.

以上において, シロカジキの時間的, 空間的な漁場構成は, 春秋によつてその意義が相違しているようである. すなわち, 冬・春季にはシロカジキは, 低温または低鹹な前線帯にその北上回遊をはばまれながらも, その附近の適正水帯側にその漁場を形成しているようである. しかし, 夏・秋季にはこのような前線帯の影響はほとんど認められなく, 海況的にはきわめて開放的になるので, シロカジキの漁場は分散的にほとんど全域にわたり出現しているようである.

春 季 漁 場

1955, 1956, 1959年の各年におけるシロカジキ, サバの漁況資料[1,6]と海洋観測資料とに

基いて Fig. 3 を画き，その春季漁場の性格について検討した．

各図に見られるようにこの季における大陸沿岸系の低温，低鹹な水帯の張出はまだきわめて明瞭であり，一方黒潮系の暖水帯の北上圧迫も非常に優勢となつており，両者の間にはきわめて顕著な潮境現象が観察されている．特に 1955, 1956 年には東海の西方を北上する中間暖水帯の先端部が黄海方面から張出している冷水帯内に浸入しており，その附近の暖水側にシロカジキとサバの漁場が集つて構成されている．

また，各年ともシロカジキの漁場附近にはサバ漁場が必ず構成されており，その分布はシロカジキにとつて生物学的環境要因[3]となつているようである．しかし，サバはシロカジキより更に低温，低鹹な水帯側に分布する場合もある．すなわちシロカジキはサバを求めてその水帯内へどこまでも潜入するのでなく，ある限度において海況的な制約を受けるようになるものと考える．シロカジキとサバの漁場水温は余り相違していなく，その最低水温はほぼ 21°C となつている．しかし，漁場の最低塩分についてはシロカジキはサバより幾分高鹹であり，その漁場は塩素量 18.6‰ 以下の低鹹な海域にはほとんど出現していないようである．

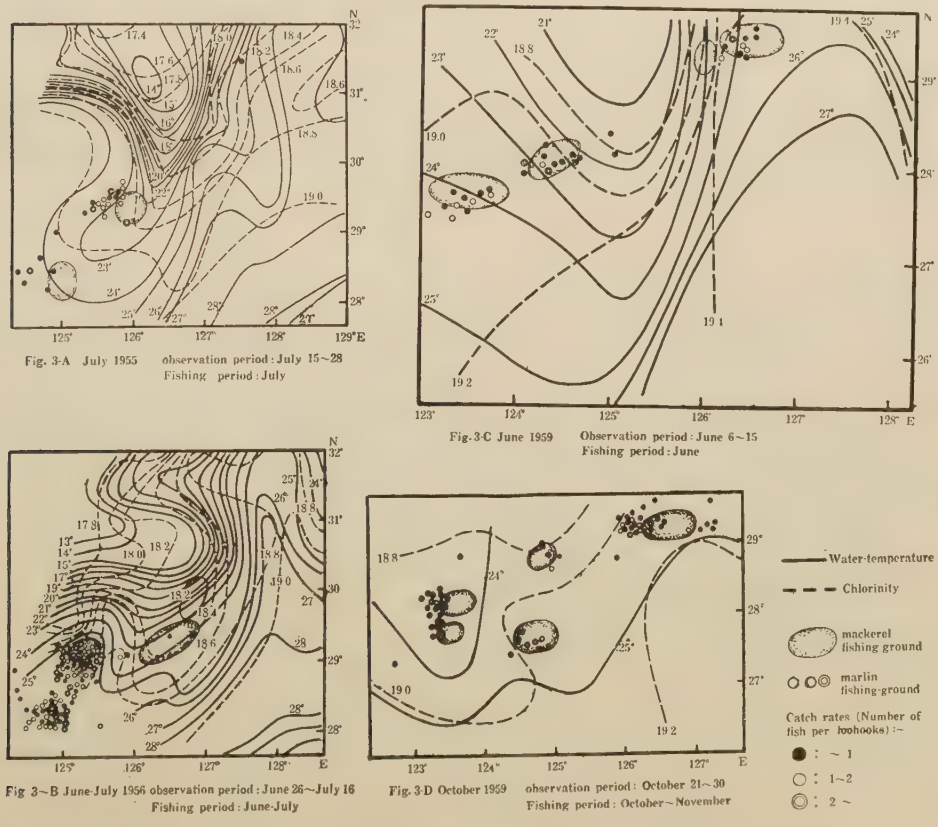


Fig. 3. Showing the white marlin and mackerel fishing-ground, the horizontal distribution of the water-temperature, and the chlorinity at 25 m layer of the central sea front of the East China Sea.

春季における東海のシロカジキは上記のようにきわめて顕著な潮境の暖水側に現われており，その環境に順応出来る範囲内において低温，低鹹な海域に回遊し，索餌目的を果しているものと考える．このため，漁場における操業位置は局部的に集合しており，その漁況は，好釣獲率を示す場合が多くなつており，概して活況を呈している．しかし，漁場附近における局部的な海況変動はその漁場構成に大きく影響するようになるものと思考する．

秋季漁場

秋季における総合的な調査資料はきわめて少なく，本篇では1959年の資料に基いて考察した．

この季におけるシロカジキの漁場海域には，低温，低鹹な大陸沿岸系水の張出が春季の場合のように明瞭に観察されなく，わずかにその形跡をとどめる程度である．

ゆえに，漁場海域における潮境現象は非常に不明瞭であり，海況的にはきわめて開放的になつている．また，その海域は，水温 23～25°C，塩素量 18.8～19.2‰となつており，春季漁場よりも概して高温，高鹹である．

しかして，この季のシロカジキ，サバの漁場は比較的広範囲に及んで拡散しており，春季のような海況条件に基く制約はほとんど観察されていない．ただ，この季は，サバ漁場附近にシロカジキの釣獲位置が集合しており，その漁場が構成されているようである．

すなわち，秋季におけるシロカジキの漁場構成は，その漁場海域がシロカジキにとつて海況的にほぼ適正な範囲内にあるので，現場の海況条件よりむしろサバの分布状況に関連する場合が多いように思考する．

結び

東支那海においては常に黒潮暖流系水と大陸沿岸系水とが相対しており，その季節的な消長はシロカジキ漁場の海況を変え，その漁場構成に非常に影響を及ぼしているようである．

すなわち，冬季には東海の 26°N 附近以北の海域が非常に寒冷であるので，シロカジキはその南部海域にのみ出現している．春夏季には全域的に昇温するが，29°N 附近以北の海域が非常に低鹹になるので，この海域にはシロカジキ漁場はほとんど構成されていない．秋季には漁場海域全般がシロカジキにとつてほぼ適正な水温，塩分の範囲内となるので，海況に条件関係なくシロカジキは全域的に拡散して分布するようになる．

また，春季の漁場海域は前記両系水の潮境が顕著に現われており，その暖水側にシロカジキの釣獲位置が集合し，その漁況は概して良好である．秋季の漁場海域にはこのような潮境はきわめて不明瞭となり，シロカジキ漁場は広く分散するようになる．

なお，シロカジキ漁場は常にサバ漁場附近に構成されており，これはシロカジキの索餌生態に伴なう現象であると考えられている．しかし，海況的にはシロカジキはサバよりも外洋性であり，低温，低鹹な海況条件による制約もサバより大である．ゆえに東海におけるシロカジキは，その適正な海況の範囲内においてはサバがその生物学的環境要因となり，サバと共にその漁場を構成するようになると思考する．

終りに，この研究のために貴重な調査資料の提供と御教示を賜つた南海区水産研究所，

鹿児島県水産試験場の関係各位に対して深甚なる謝意を表する．

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鹿児島湾内産主要魚類の漁況と環境要因についての研究—IV

小アジについて

田ノ上　豊隆

Studies on the Relation between the Fluctuation in Catch and the Environmental Factors of the Principal Fishes in Kagoshima Bay—IV

On the Young Horse-Mackerel, *Trachurus Japonicus*

Toyotake TANOUE

Abstract

(1) Fluctuation in the catch of young horse-mackerels in Kagoshima Bay has been studied through a survey of statistical data on the catch at twenty fishing ports on the coast of the bay (Figs. 1 & 2). Young fish are chiefly caught in the waters where the depth ranges from 30 to 50 m (Fig. 3). In the inside of the bay the fishing is principally performed during the months from April to October, while fishing season at the entrance of the bay is mainly confined to a period from November to March.

(2) The distribution of body-lengths in the catch was studied monthly between March and December 1959 (Fig. 4, Table 1). The great majority of the catch is occupied by small-sized (6–14 cm in the body-length) individuals, a small portion consisting of large-sized (15–21 cm in the body-length) animals. Referring also to the culture experiment of young fish (Fig. 5, Table 2), it is postulated that the above stated small-sized fish are in their first year and the large-sized animals are in their second year.

(3) Seasonal variations in the hydrographical conditions in the bay as observed in the monthly oceanographic surveys are shown in Fig. 6 and Fig. 7. The migration of young horse-mackerels into the bay takes place in spring, most probably when a water temperature at 25 m depth is raised over 17°C; the migration to the outside of the bay seems to occur in autumn with the lowering of the water temperature.

I. 緒　　言

マアジ（*Trachurus japonicus*）は，鹿児島湾内において，八田網（夜間操業，集魚灯併用）の漁獲対象として極めて重要な資源である．

漁獲量は 1958 年に 1,300 トン，1959 年に 1,500 トン程度に増加し，アジ類（他にムロアジを含む）の 90% 以上を占めて，片口鰯に次いで多獲されている．

特に最近は，イワシ類，小サバ等の洄游魚の水揚げが減少の傾向にあるので，アジの重要度は増大して来た．

筆者は湾内重要魚類の漁況研究の一環として，今回は 1958～'59 年のマアジの漁況変動，魚体組成，海中飼育マアジの生長と湾内棲息群の体長分布の比較検討，漁場環境等について調査したので報告する．

II. 漁 況 概 要

農林統計資料中で鹿児島湾内の主要水揚港 20 港（山川，指宿，今和泉，喜入，岩本，谷

山，平川，鹿児島，加治木，国分，小浜，牛根，福山，垂水，古江，高須，根占，大根占，佐多，赤水）を選び，各漁協の集計に基いて，月別の漁獲量の変動をみると，Fig. 1 に示す如く，漁期は周年におよんでいることが判る．

しかし，総体的には 11月頃から翌年3月頃までの漁獲量は極めて少く，冬季は閑漁期となり，4月から 10月までの漁獲量は比較的多く，6月と 8 月には顕著な漁獲量のピークも現われており，この期間が湾内のアジの盛漁期とみられる．

鹿児島湾は湾口から湾奥の最北部まで 35 浬以上もあり，その形状は湾口，中央部，奥部の三海区に区分される．

殊に湾奥部は桜島によつて区切られた様な型で，他の海区と海況も異[1]つている．従つて魚群の来游にも湾口部と相異が予想されるので，比較的機動性に乏しく，地先漁場で操業している隼人，国分，小浜等の漁獲量の変動を Fig. 2 に示した．図でわかる通り，漁獲量は 1958 年に 60トン，59 年に 70トン程度で湾内総漁獲量の 5％位にすぎない．これに牛根其の他の漁協の水揚を加算して 2 倍位とみても，大体 10% 程度が湾奥部海区で漁獲されている事となる．

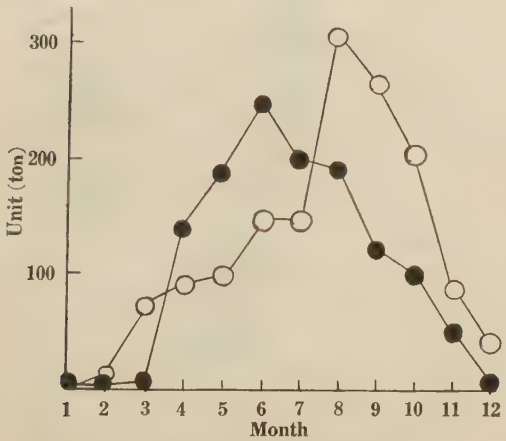

Fig. 1. Seasonal variation in the catch of horse mackerels in Kagoshima Bay in 1958 and 1959.

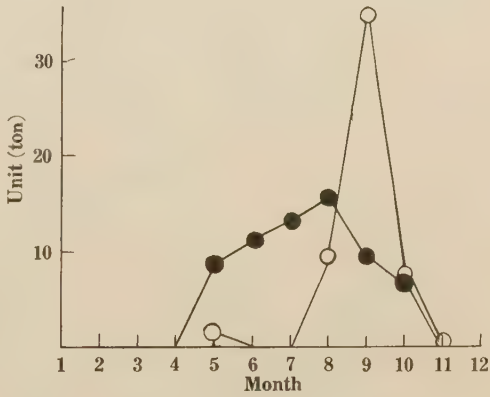

Fig. 2. Seasonal variation in the catch of horse mackerels off the northern side of Sakurashima in 1958 and 1959.

1958：—●—　1959：—○—

漁期は 5 月にはじまり10月まで続き，11月には殆んど漁は終る．月別漁獲量のピークは 8，9 月に現われて，湾内の全般的傾向より稍々遅れる傾向が認められる．

即ち湾奥部では，魚群の洄游は他の海区より若干遅れて 5 月頃来游し，8，9 月の盛夏に最も多く，10月末には主群は南部へ移動するものと推定される．

漁場の分布は Fig. 3 に示す如く，全般的に水深 50 m 附近および以浅の海域に多く，湾中央部の最も深い海区に漁場が形成されることはない．

小サバ群[2]とは漁場を同じくする場合が多く，体長差の少い春季に最も良く混獲される．

現在八田網，四艘張網（昼間操業）等の好漁場となつている海区は，薩摩半島側の谷山沖から喜入，今和泉沖の 30～50 m 水深の海域であり，4 月から後述する中型・小型魚が多獲されている．山川港外，稚児ケ水方面は晩秋と翌早春の頃に好漁場となる．大隅半島側

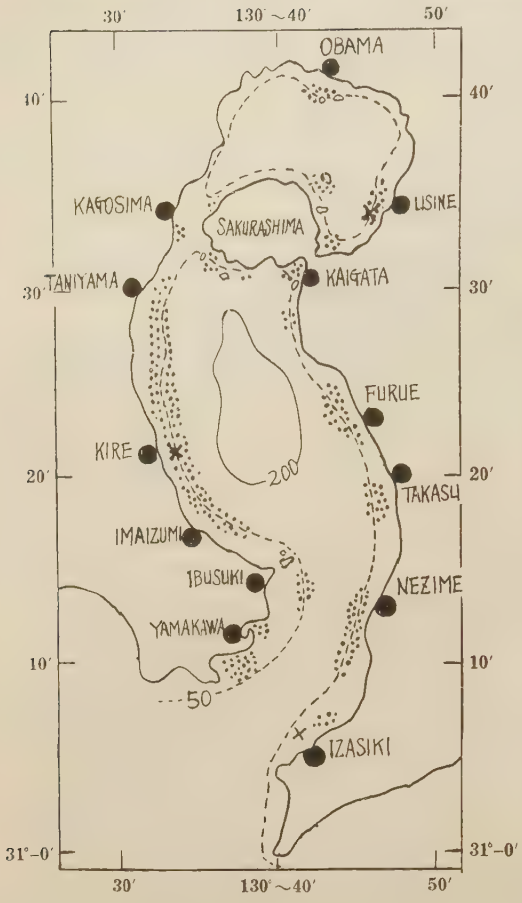

Fig. 3. Location of the fishing grounds (dotted area) and certain stations of hydrographic survey (×) in Kagoshima Bay.

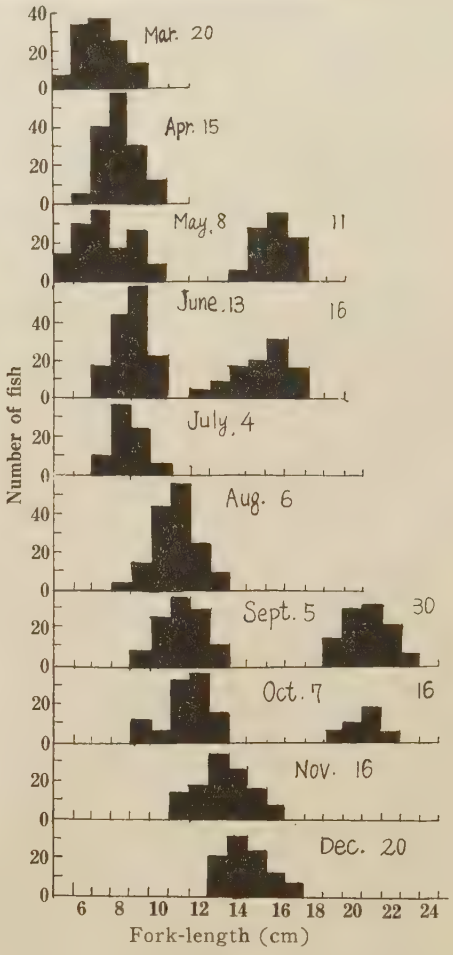

Fig. 4. Fork- length distribution of horse-mackerels in Kagoshima Bay, 1959.

Table 1. Annual variation of the body length of young horse mackerels, 1959

Date	Number of fish	Body-length (cm)	
		Mean value	Range
Mar. 20	117	7.2	5.2~ 9.4
Apr. 15	143	8.5	6.0~10.8
May 8	133	7.8	5.6~10.8
〃 11	93	16.3	14.0~17.3
June 13	137	9.4	7.0~10.6
〃 16	94	16.0	12.2~17.5
July 4	74	8.8	7.0~10.8
Aug. 6	150	11.3	8.0~13.5
Sept. 5	106	11.7	9.2~13.4
〃 30	97	21.6	19.0~23.2
Oct. 7	96	12.3	9.4~13.7
〃 16	35	21.2	19.0~22.5
Nov. 16	110	13.6	11.2~16.4
Dec. 20	92	14.7	13.0~17.2

は湾口部に近い伊座敷方面の定置網によつて若干漁獲されるが，漁場は根占沖から高須，古江沖に至る海区と海潟から桜島南部が主漁場となる．

根占沖は秋期における中型魚の一本釣漁場としても重要な海区である．なお同海区は秋期にムロアジの好漁場となるが，この事については別に報告する．

III. 体 長 組 成

1959年に知林島から谷山沖にいたる薩摩半島側漁場で，八田網によつて漁獲されたマアジの体長分布は Fig. 4, Table 1 の通りで，体長範囲は 5 cm 位の小型魚から 23 cm 程度の中型魚まで出現している．

月別の体長組成をみると，3月下旬頃から4月に6～7 cm にモードを持つ小型群が現われ，5月にはほぼ同程度の体長群と 14～16 cm 範囲の中型魚群も出現している．この後7月まで，小型魚のモードの移行は極めて小さく，成長状況も不明瞭である．おそらくこの間には小型魚の添加が続き，群間の離集が激しくて，一定の成長傾向を端的に表示しない為にこのような現象が生ずるものと考えられる．

8月以降になると，10 cm 以下の小型魚の数は比較的少くなり，モードは 11 cm 程度から漸次増大して年末には 14 cm 程度に達する．

中型魚については毎月の詳細な調査資料がないので，良くわかつていないが，5, 6月に 14～17 cm の体長範囲の群が現われ，9, 10月には 19～23 cm の範囲で 21 cm にモードを持つ群が出現している．

以上の体長分布から，湾内で漁獲されるマアジ群は，前記の小型魚群と中型魚群の両型があることがわかる．

次にこの両型群を飼育マアジの成長状況と比較してみよう．

Fig. 5, Table 2 は田ノ上[3]が1956年6月から'57年6月までの1年間，鹿児島湾内の海潟港と水産学部沖合において，生簀内で毎日1回の投餌を続けて飼育したマアジの成長傾向を示したものである．

この結果によると，6月に平均体長 9 cm の魚体がその年の終りには 13.9 cm に達し，最大体長 16 cm 台に成長している．又翌年4月には平均体長 18.3 cm で最大体長は 20.1 cm に達している．

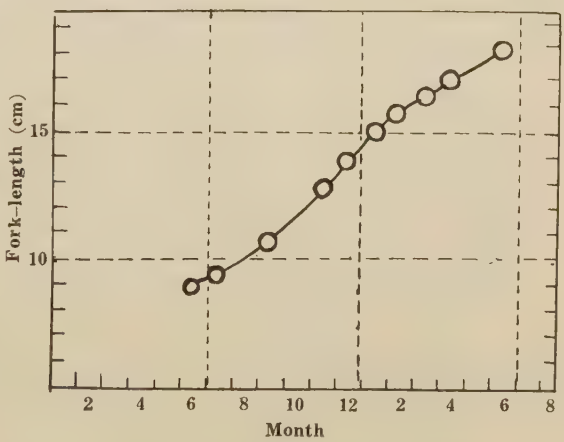

Fig. 5. The growth curve of reared young horse mackerels in Kagoshima Bay,1956～1957.

飼育魚と天然棲息群とは摂餌量，環境等の相異に基く，成長の差異は勿論考慮しなければならないが，成長曲線でわかる如く，アジの成長はサバ等に較べて遅い[4]ので著しい差異はないものと推定される．

この飼育魚の成長から判断すると，前記の小型魚群のモードの移行は春湾内に来游する

Table 2. Annual variation of the body length of reared young horse mackerels, 1956～'57

Date	Number of fish	Body-length (cm)	
		Mean value	Range
June 18	26	9.0	8.2～10.1
July 2	68	9.4	8.2～11.5
Sept. 20	55	10.8	9.0～13.3
Nov. 28	51	12.7	11.0～14.6
Dec. 25	48	13.9	12.0～16.6
Jan. 21	35	15.2	13.2～17.8
Feb. 27	51	15.8	14.1～17.9
Mar. 26	42	16.6	14.3～18.5
Apr. 20	45	17.1	14.7～19.0
June 20	45	18.3	15.5～20.1

群の成長を現わすもので，年末に同系統群が 14 cm 台に達したものであろう．又 5 月にみられる中型魚は前記小型群が成長した 1 才魚群であり，秋にみられる 21 cm 程度の群と同一系統と推定される．此の結果は山田[5]の成長調査結果とも良く合致する．

即ち湾内では当才魚群と 1 才魚群が漁獲の対象になつているようである．

中型魚は 25 cm 以上になると湾内で漁獲されないので，この年の冬から湾外の沖合に移動棲息するものと考えられる．

IV. 水温，塩分の変化と漁況

魚群の棲息移動に最も影響をおよぼしていると推察きれる 25 m 層の水温の月別変化を Fig. 6 に示した．図中の St. 1, 12, 26 は夫々湾口部，奥部の漁場内の一点であり，水温は毎月上旬に実施している湾内定期観測の資料を用いた．

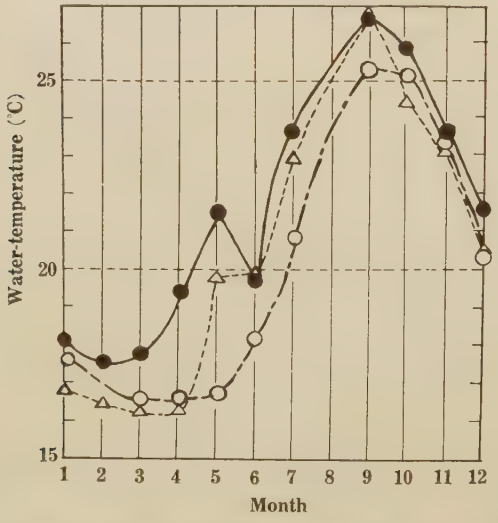

Fig. 6. Annual variation of water-temperature (°C) at 25 m depth, 1959.

St. 1: —●—
Lat. 31°-06.0′ N,
Long. 130°-41.0′ E

St. 12: - -△- -
Lat. 31°-22.7′ N,
Long. 130°-34.5′ E

St. 26: —○- -
Lat. 31°-35.5′ N,
Long. 130°-46.1′ E

先ず年間の水温変化をみると，冬季に 16°C 程度に低下し，夏季に各点共 26°C の高温に達すること，昇温の時期は湾奥部ほど遅れる事が良くわかる．

St. 1 では最低温期は 2 月であるが，水温は 17°C 台の比較的暖水で覆われ，3 月になるとすでに昇温の傾向がみられる． 9 月になつて 26°C の最高温に達してその後は漸次降下

しはじめる．

St. 12 では最低温期は 3 月で稍々遅く，4 月に漸く 17°C 台に達し，その後の変化は St. 1 とほぼ同様である．

St. 26 では最低水温の時期は更に遅く，5月になつて漸く昇温の傾向が認められる．しかし本海区では 6 月に 17°C 台に達し，湾口附近の水温分布とかなりの相異のあることが判る．

最高水温に達する時期は各海区共 9 月であり，10月以降水温は降下しはじめるが，湾奥部では 10月の較差は他の海区程大きくない．

この水温変化状況と前記の漁況変動との関連性を観察すると，湾口から湾中央海区で漁況の活潑化する 4 月は同海域の水温の昇温期であり，水温の最も高い夏季に漁況は最も活況を呈する．又水温の下降しはじめる 10，11月が終漁期となる．

湾奥部の漁期の遅れは，17°C 台の水温に達するまでの時間的な遅れとみることができよう．

湾中央部漁場の St. 12 における 25 m と 50 m 層の塩分変化を Fig. 7 に示す．

塩分は 33.0～34.7‰ の範囲で，概して冬・春季に高く，夏・秋季に低い．特に 25 m 層で低下の現象は顕著である．

アジの盛漁期となる 4～10月の塩分は大体 33.6～34.3‰ 程度の範囲で，比較的高鹹な，いわゆる混合水帯である．

冬季の高鹹水は低温であり，湾内の中・底層水の対流混合による影響が大きいものと推定される．

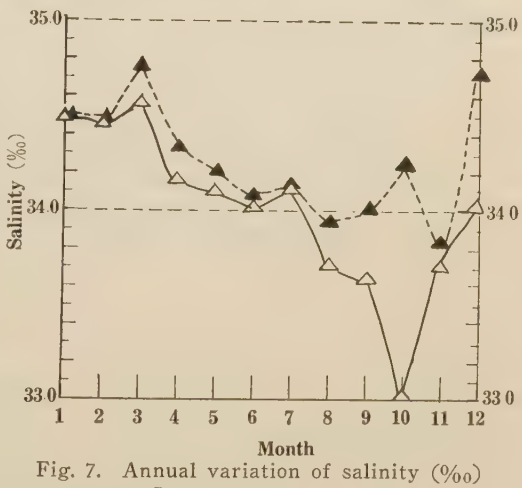

Fig. 7. Annual variation of salinity (‰) at St. 12, 1959.
25 m depth: —△— 50 m depth: —▲—

アジは塩分に対する適応範囲[3]はかなり広いので，冬季の塩分変化が群の棲息に直接の影響を与えるとは考えられない．しかし，低温・高鹹な底層水の出現はアジ群の移動を促進する原因として考慮すべきであろう．

V. 要　　約

鹿児島湾内のマアジ漁況と海況について考察し次の如き結果を得た．

1) マアジの漁場は水深 50 m 以浅の海域に広く分布し，中でも谷山—今和泉沖が最も好漁場となる．盛漁期は湾中央部で 4～10月，奥部は 5～10月で稍々遅れる．湾口部から湾外の漁期は晩秋から 3 月頃である．

2) 魚体は 6～14 cm の小型魚（当才魚）と 15～21 cm 程度の中型魚（1 才魚）の両型がみられる．

3) 漁場の 25 m 層の水温が 17°C 台以上に上昇した後漁獲がはじまり，高温期（6～9月）に漁況は最も活況を呈し，水温が下降しはじめると終漁期となる．

漁場の水温・塩分範囲は夫々 17～26°C，33.6～34.3‰ であつた．

終りに統計資料を提供して頂いた鹿児島農林統計事務所の関係各位，湾内観測を担当された練習船しろやまの高橋船長以下乗組員各位に深く感謝の意を表する．

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新設動揺試験水槽の構造並びに性能について

奈良迫　嘉一

On the Structure and Performance of a Newly-set Rolling Test Tank

Yoshikazu NARASAKO

Abstract

A rolling test tank to be used in a hydraulic study on the ship-rolling has been set up in the common central water way of a large-sized tank which consists of two symmetrically situated, elliptical circulating channels (Fig. 1). A ship-rolling recorder and a wave-height recorder are attached to the carriage which permits minute movement. A pneumatic wave-maker is constructed so as to change optionally the air pressure inside an inverted case which is partly immersed into the water (Fig. 2). The wave-damper is of a beach type (slope 1/5) with a grating of square laths. Other data of the structure of the tank are as follows: length: 10 m; effective length: 4.2 m (from the wave generator to the model); effective width: 2 m; depth: 1 m; effective depth: 0.8 m; capacity of the wave generator: 1 H.P.

Generated waves are approximately trochoidal in form, i.e., a deep-water wave (Fig. 9). Other characteristics of the waves follow: maximum height: 11 cm; period: 0.8–1.5 sec.; slope angle: 6°–2°; steepness: 1/30–1/80.

Experiments with a model ship (Figs. 12, 13a & 13b) together with the features of generated waves (Figs. 9, 10 & 11) show the usefulness of the tank as a practical testing apparatus.

1. 緒　　言

先に本学に於ては大型対称式回流水槽を設置し，これに依つて漁船，漁具（定置網，巾着網等）の流体抵抗を測定し，流体力学的検討とそれに依る資材の効率的設計を通じていささか漁業の発展に寄与して来たが，今回更に本水槽の中央水路を利用し，幅 2 m，深さ 1 m，長さ 10 m の動揺試験水槽を整備した．近時漁船等小型船舶の復原及び動揺性能の向上に国家的関心が深まりつつあるとき，吾々も本水槽に依つて学生に是等の問題に関する実際的概念を与え，併せて教官研究の一助に資し得ることは大きな喜びであり，玆に本水槽の施設拡充に就て種々御高配と御援助を賜わつた日本海難防止協会に対し深く感謝の意を表するものである．本報に於ては主として動揺試験水槽の構造並びに性能の概要について報告する．

2. 実 験 装 置

元来本水槽は動揺実験のため特に設計，設備せられたものでなく，上述の如く既設の抵抗試験用水槽の中央水路の直線部を利用したもので，其の大きさ並びに形状については必ずしも理想的でなく，特にその長さが著るしく短く水深も浅いのが欠点である．今その寸法，形状を示せば Fig. 1 の如くである．即ち動揺試験水槽としては中央直線水路の一端に造波装置，是より約 4.0 m 離れて模型実験を行う微動計測台車を置き実験中は軌道上を前後に自由に移動し得るようにしてあり，その後方固定整流板に続いて左右両側に別れた円弧状の彎曲整流板の夫々の終端の位置に消波装置が置かれている．

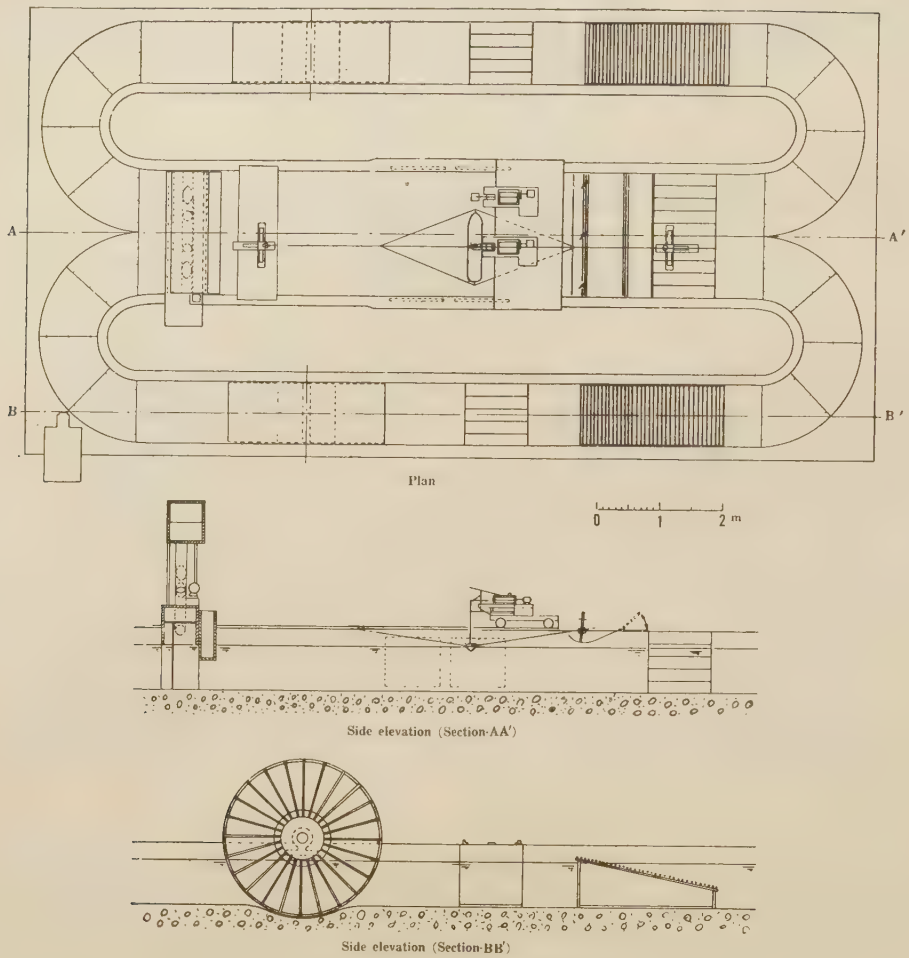

Fig. 1. Rolling test tank.

1. 造波装置　既設水路に実験設備を置く関係から，水路の有効長さが極めて短かく限定されること，浅海波，深海波何れも発生可能なることが望ましいこと，造波装置の運動と発生波の特性（波高，波長，周期間の関係）を経験的に推定できること，建設及び維持が簡単で且つ低廉であること，反射及び慣性が小さいことという観点から，造波装置は空気式のものを選定した．Fig. 2 に示す通り，上部気密箱の左端に吐出口を下にして 0.75 KW 送風機を格納，その吐出口に同径の鉛直エスロンパイプをつなぎ下部開箱内水平エスロンパイプへ導く．この水平パイプには対称に同様の鉛直パイプが設けられ上部閉箱へ風路を導いてある．尚開箱内水面への風圧を均一化するため水平パイプには前後両面何れも中央部全長に亘つて水平に開口を設けてある．更に連通管内の水の動揺周期を 0.8～1.5 sec に共振させる目的で開箱の前面に図の如く外箱を置いた．又両鉛直パイプの中間には何れもト字状に枝管を設け夫々内部空気の出入口に当てられている．パイプ内各弁を電磁オシロ用可変速 1/16 H.P. モーターに依り或る周期を以て開閉すれば左鉛直パイプは常に下方の開箱へ空気を送り込み，右鉛直パイプは反対に空気を吸い込むこととなり，箱内の気圧が

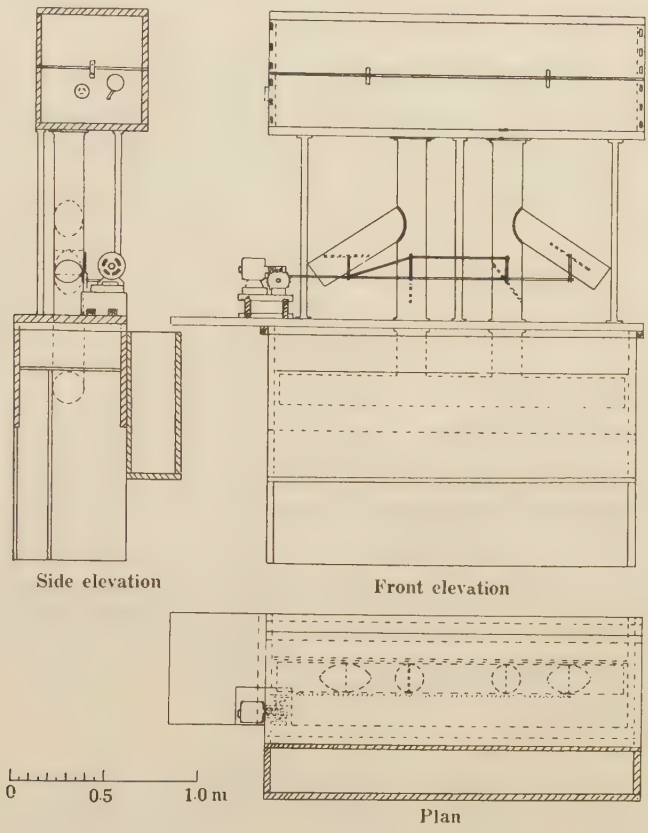

Fig. 2. Wave generator.

周期的に変動し，従つて種々の造波が行われることとなる．尚送風機は特殊風圧調整器をもち風量及び風圧の増減が可能であり，この使用に依つて発生波の波高を変えることが出来る．

備考　**上部気密箱内送風機**

三相交流誘導電動機 0.75 KW，電源　三相交流低圧動力 250 V，吐出口径 150 mm，周波数 60 cycle，風量 22 m^3/min，風圧 158 Aq mm，毎分回転数 3470，電流 3 A，電圧 200 V，定格連続極数 2.

エスロンパイプ内弁開閉用電動機

電源 A.C. 100 V→12 V，馬力 1/16 H.P.，電磁オシロ用可変速モーター，電流 7 A，電圧 12 V.

2. 消波装置　消波装置は消波能力大で反射波を生ぜず，安価で且つ占有面積が少くて済む方式が望ましいが，従来使用されてきた構造では，海浜での波のエネルギー消失現象を模倣した斜面形式の改良型が一般に好評である．吾々の場合もオランダ N.S.M.B. 航海性能試験水槽に於て好成績を挙げていると云われる海岸傾斜式（H/L＝1/5）を選定した．

Fig. 3 にこれを示す．実験の結果では最大波長 4.5 m のとき，反射波の波高は入射波のそれの 5％以下，これより短い波長の波に対しては条件は更によくなると云われている．

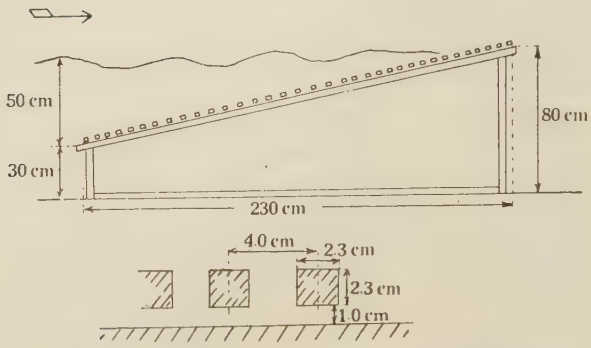

Fig. 3. Wave-damper, side-elevation.

当然本消波装置は直線水路に設けるべきであるが，前述の如く水槽の有効長さも短かく，設置に困難なので甚だ不本意ではあつたが左右両側の枝水路にこれを置いた．

3. 動揺角並びに波高測定用微動計測台車　Fig. 1 に示すように中央直線水路コンクリート側壁上に設けられた軌道上を微動し得るもので，大きさは 2.2 m×1.1 m，これに自記式動揺計 Fig. 4，及びその構造，作動原理も略々前者に同じ波高計 Fig. 5 が置かれてある．模型船保持の方法としては Fig. 1 に示す如く動揺計が模型船に対し重心の上下運動，回転運動並びに水平往復運動を同時に許し且つ水平の横漂流を与えた場合でも計測出来るよう末広博士の改良型を用いた．

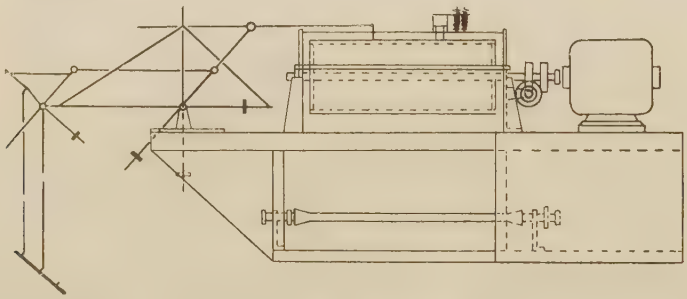

Fig. 4. Rolling recorder.

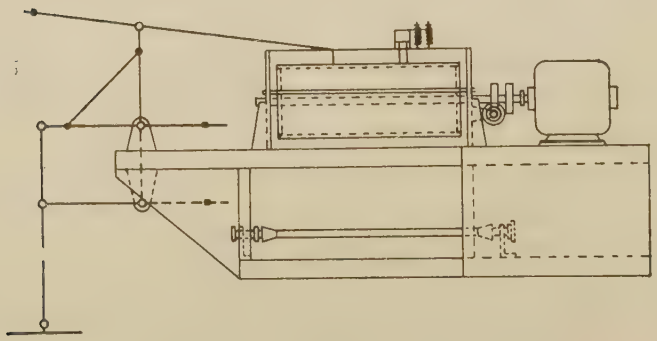

Fig. 5. Wave-height recorder.

3. 水槽の性能

造波装置の弁開閉用モーター回転数と発生波の周期との関係は Fig. 6 に示す通りである．又送風機の特殊風圧調整器全開時の波高と周期との関係は Fig. 7 に示された通りである．周期を一定に押えた時の波高の時間的変動は Fig. 8 に示す通りである．　尚発生波の波形を調べる目的でこれを観測窓より写真にて撮影，これを写真引伸し器で引伸したものを求

Fig. 6. The Relationship between r. p. m. of motor and Tw.

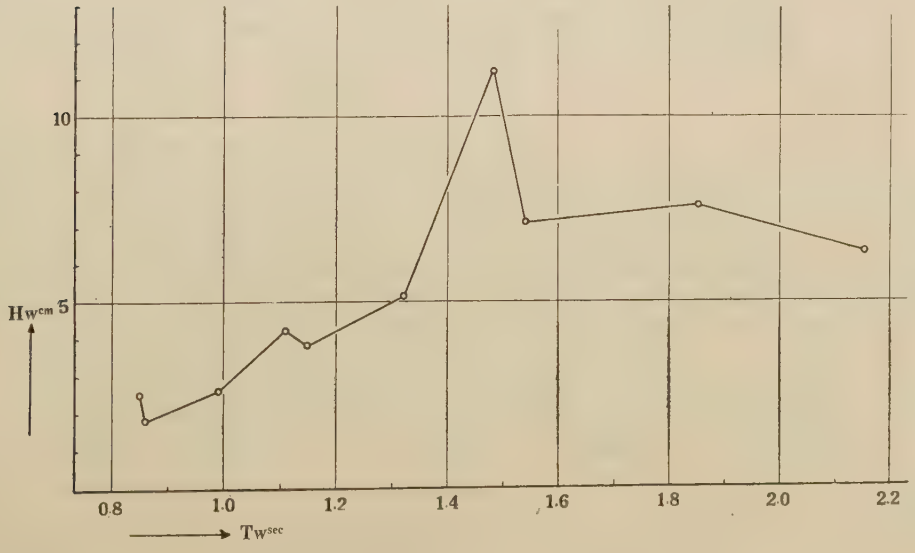

Fig. 7. The Relationship between Hw and Tw.

Fig. 8. Variation of Hw when Tw is constant.

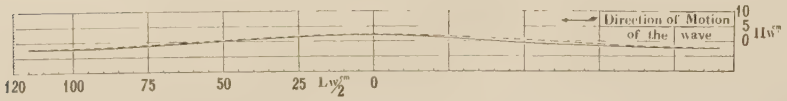

Fig. 9. Wave Profile.

---- Trochoidal Wave, —— Wave of Tank.
Period of the wave 1.23 sec, Length of the wave 230 cm, Height of the wave 4.5 cm.

めると略々トロコイド波形であつて，Fig. 9 がそれである．又波の長さと周期との関係を実験的に調べてみると Fig. 10 の如くであつて略々理論式 $L_w = g/2\pi\ T_w^2$ の関係を満足している．L_w, T_w 及び造波装置内弁開閉用モーターの r.p.m. との関係を示せば Fig. 11 の如くである．最後に本装置に依る模型船の自由動揺並びに強制動揺試験記録の一例を示せば Fig. 12, 13a, 13b である．

4. 考　　察

動揺試験水槽として水路が他端で楕円弧状に曲つて消波装置につながることから発生波の進行に伴なつて側壁への反射並びに回折を生ずる事から消波装置に依る反射波の波高の減衰効果についてはかなり疑問をもたれた．又通常造波装置と模型船間の距離は少くとも模型実験波の最大周期 1.5 sec と最大水深 0.8 m に対応する波長 3.22 m の 3 倍の約 9 m が必要とせられるが，現水槽ではどうしても 4.2 m しかとれず造波装置に依る波状攪乱は模型船の位置附近に於てもかなり残留し，模型波の定常化並びに波形の歪みについては当然大きな危惧と困難が予想された．唯吾々としては空気式造波装置の特性である慣性がないこと，反射性が弱いことに期待をかけて実験を行なつた．即ち波の長さと周期との関係を実験的に調べた結果は Fig. 10 の通りで測定周期の範囲内では理論波に対し最大 2 % の誤差であり，一応動揺試験水槽としての使用が可能と考えられる．但し Fig. 7 に示す通り各種波形に対し波高を整一にすることはその機構上経験的に推定せざるを得ず調整は特

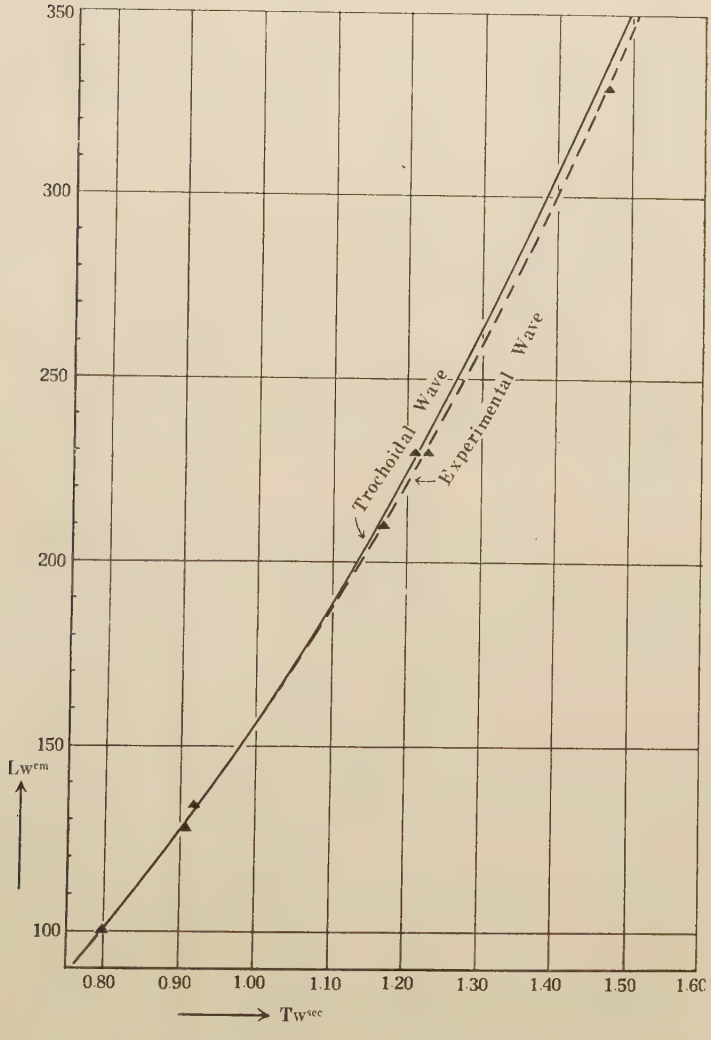

Fig. 10. The Relationship between Lw and Tw.

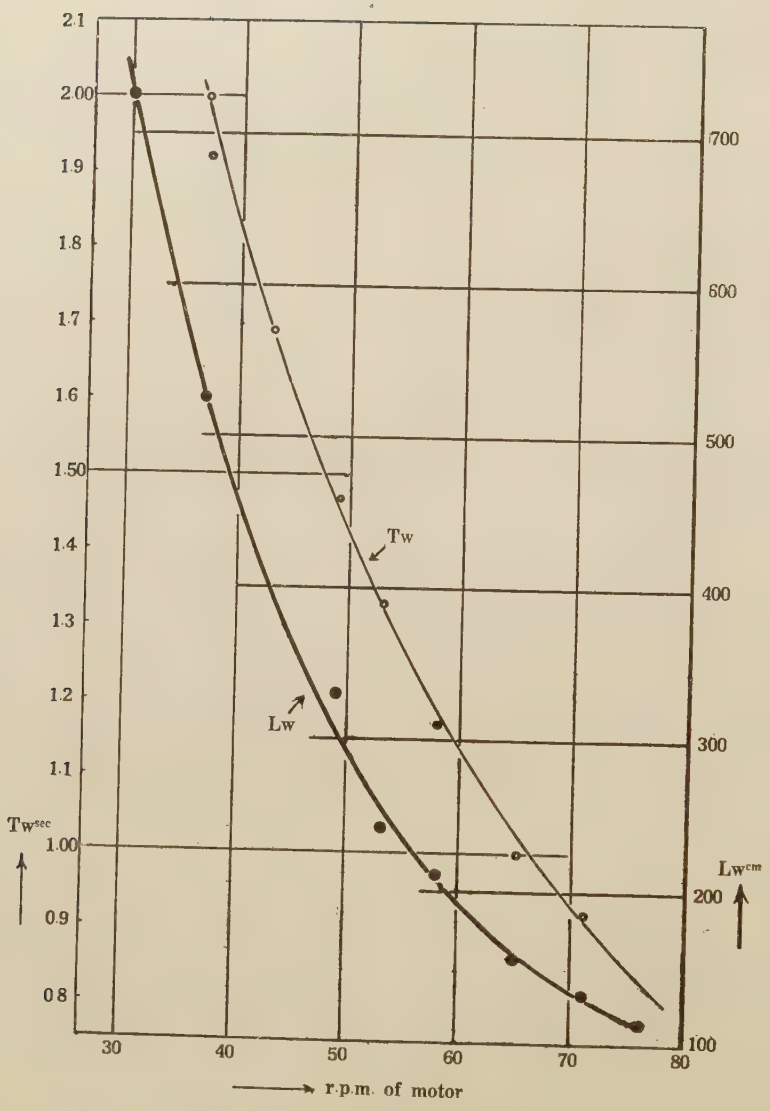

Fig. 11. The Relationships of Lw and Tw to r.p.m. of motor.

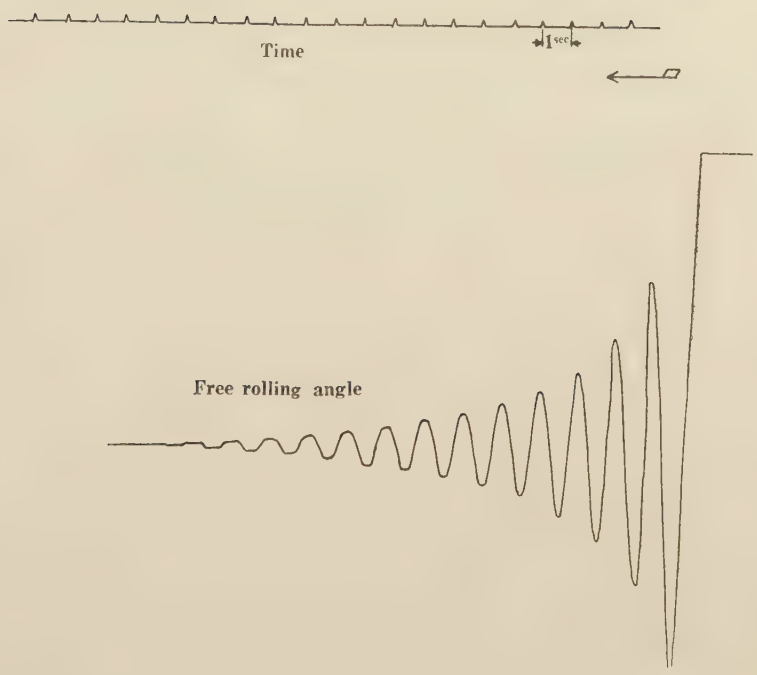

Fig. 12. An example of free rolling test record (θ).

に困難を極めた．今後本水槽の性能を向上せしめるとしても水路の長さ並びに水深に制約されて或る限界があると思われるが，消波効果について更に一段の工夫改善をすれば若干の性能向上が期待出来よう．

5. 結　　言

1. 模型船用実験波では周期 0.8～1.5 sec の範囲では波形も概ねトロコイド波で深海波に近い．概して周期が大きくなると，波長が理論波よりも短くなり 1.5 sec の周期の時最大 2 % の誤差である．

2. 上記周期の範囲で波長は 1.0～3.5 m，波高は送風空気量の函数で最高 0.11 m，波傾斜角は 6～2°，波の峻度は 1/30～1/80.

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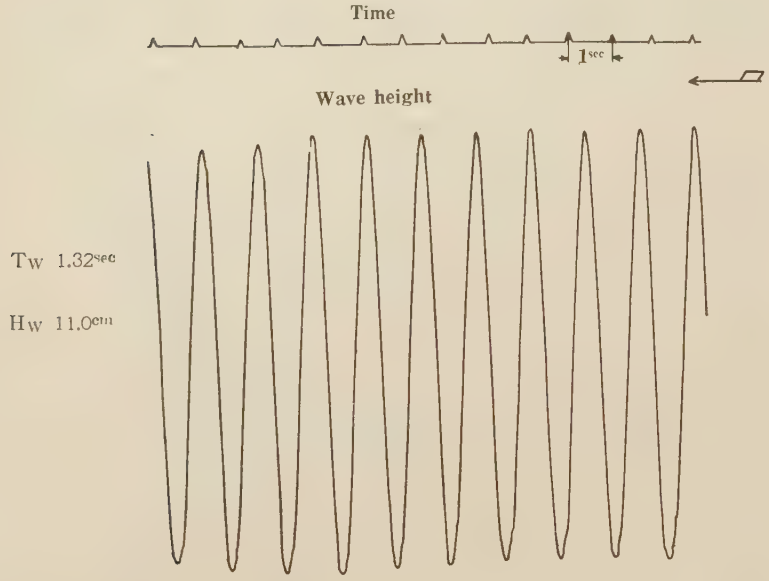


Fig. 13 a. An example of forced rolling test record (Hw).

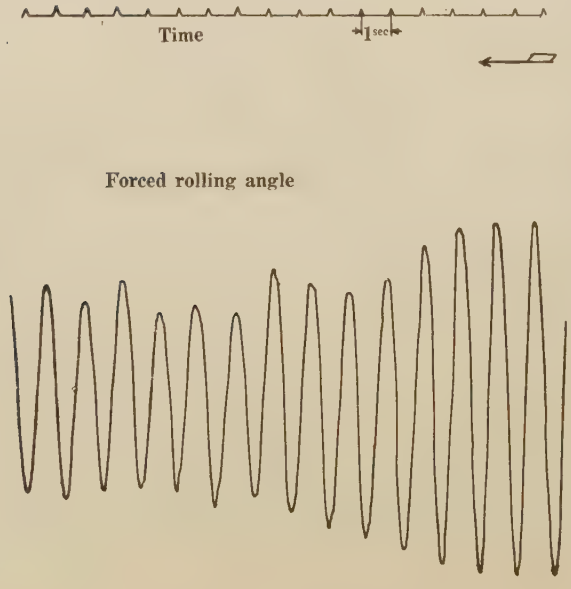


Fig. 13 b. An example of forced rolling test record (θ).

(続) 定置網に働く流水抵抗に関する研究

金　森　政　治

Further Report on the Physical Analysis of the Fixed-Fishing-Net Resistance

Masaji KANAMORI

Abstract

(1) An electric strain meter, with a newly devised highly sensitive water-proof strain gage, was used in the water in the measurement of the force to the sand-bag rope of a model fixed-net.

(2) The following equation is obtained experimentally:

$$S = S_0 e^{-kV}$$

where, S is the area of the net projected on a plane perpendicular to the current, S_0 is that area when the current velocity is zero, and V is the current velocity.

(3) Using S and $1/2\rho V^2$, the coefficient C_P for various types of nets has been obtained by applying the dimensional analysis to the horizontal component of the force P to the sand-bag rope.

(4) It has been found out that when the sinker is detached from the bottom there is a hydrodynamical force acting upwards, and the net shows a wing-like character. It is postulated that, even when the sinker is not detached from the bottom, the above stated wing-like character appears to the part inclined toward the direction of the current.

概　　要

(1) 定置網の水中における抵抗を推定するために，実物網及び土俵綱の縮尺模型を作つて，土俵綱の水底となす角度をも等しくしておいて，土俵綱にかかる力を測定し，それを解析して，網に働く流水抵抗を求めた．力の測定には，始めは天秤を使つたが，後には，電気抵抗歪計を使用し，張力計を土俵綱の土俵の位置に取付けた．このために，水中で使用できる防水した高感度の張力計を新しく考案した．

(2) 流れに直角方向への定置網の射影面積を S，そのときの流速を V cm/sec，流速が零のときの面積を S_0 とすると，

$$S = S_0 e^{-kV}$$

なる関係があることを見出した．k の値は，網の種類及び流れの方向により異り，流れが 20 cm/sec までの範囲では，0.012～0.057 sec/cm の範囲にある．

(3) 変形した状態での射影面積 S と，$1/2\,\rho V^2$ を用いて，土俵綱に働く力の水平分力 P を無次元化した係数 C_P について調べると，

(3a) 平面網では，流速 10～15 cm/sec 附近で，C_P は極小になり，その極小値は $4\sim7\times10^{-4}$ で，土俵綱の長いほど C_P の値は小さい．

(3b) 真四角な箱網では，C_P は流速と共に増加する傾向があるが，平面網の場合よりも一定値に近く，$3\sim9\times10^{-4}$ の範囲におさまる．

(3c) 複雑な形の実際網では，網の種類，流れの方向及び流速によつて，C_P の値は実験値 47 例中，極端な値を除けば，$1.0\times10^{-4}\sim21.0\times10^{-4}$ の範囲にある．

(3d) 真四角な箱網及び複雑な形の実際網の C_P が，平面網の C_P より小さい場合のあることは，沈子が水底に着いているときには，流体力学的抗力のうち，沈子に働く部分が割合に多くなるためであるとして理解される．

(4) 沈子が水底から浮き上つている時には，網に流体力学的な揚力が上向きにも働き，翼に似た性質を持つことを始めて見出した。この時の網の流体力学的な揚力と抗力との比は，0.12～0.22 で，土俵綱が長いほど小さく，又流れがおそい程大きい値を持つ．沈子が水底から浮き上つていない時でも，流れに対して傾いている部分は翼のような性質を持つていると推定される．

緒　　言

(1) この論文の原論文* は，漁撈の立場から，漁網に働く力の解析を行い，更に従来のこの種の研究の立場を一歩進めて，流体力学的な考察を多分に加味したものである．本論文では，流体力学者と共通な表現様式を採用して結論を述べ，併せて原論文の表現の不足，或は不適切であつたところを，追加訂正することを目的とした．

(2) 従来は，漁網に働く力を知るために，(I) 網地を四角な枠に張つて，流れによる網の変形を最小限にして，網の面に直角に働く力を測定し，或は (II) 漁網（模型網）の土俵綱を水平となるように張つて，その状態で土俵綱に働く力を測定して，漁網に働く流水抵抗を計算していた．然しこれでは，いずれの場合も網の変形が実際の状態と異り，相似性が成立しない．それ故に原論文は，漁網自身を相似に保つたのみならず，土俵綱の長さを変化させることによつて，土俵綱の方向についての幾何学的相似性をも考慮した．

(3) 原論文を読み易くするために，次の説明を追加する．尚誤植の訂正を本論文の末尾に掲げた．以下原論文と本論文の表及び図などを区別するために，前者の関係のものは総て **Gothic** で記した．

1) **Table II, III** の最初の欄，Name and characteristics of Net の欄中の総ての Sum Total of Buoyancy の B は B^* とする．従つて B/W は B^*/W となる．ここで B^* は，浮子が全部水中に沈んだときに生ずる浮力を意味する．

2) **Table III** の最初の欄において，Square-Net, Flat-Net に夫々 A, B, C の符号を附したのは，B^*/W の値が，A は 0.5, B は 1.0, C は 2,0 であることを示す．

3) **Fig. 4–a, b, c** 及び **Fig. 5–a, b, c** における A, B, C の符号は，土俵綱の長さが A は 60 cm, B は 90 cm, C は 120 cm であることを示す．

4) **Table II** の最初の欄に示した網が，**Fig. 1** のどれに対応するかを表示すれば第1表の通りである．

第　1　表

Table II	Fig. 1	Table II	Fig. 1
(1) (1－a)	(A)	(8) (1－b)	(D)
(2) (1－a)	(B)	(10) (2－b)	(E)
(4) (1－a)	(C)	(11) (2－b)	(F)

* Kanamori: On the Physical Analysis of the Fixed-fishing-net Resistance, Memoirs of the Faculty of Fisheries, Kagoshima University. Vol. 8. 1960. Feb.

又 **Fig. 3–a, 3–b** が **Table II** のどの網に対応するかを表示すると，第2表の通りである．

第　2　表

Fig. 3	Table II	Fig. 1
(3－a) (3－b)	(1)　(1－a) (10)　(2－b)	(A) (E)

5) **Fig. 11 の (a), (b)** の 0 点を通る水平線を H_0H とし，H_0H と水底との距離を D とする．土俵網の長さを l とする．

6) **Table III の 12, 13 欄**の左側の数字は，夫々完全に水中に没した浮子の数及び底から浮き上つた沈子の数である．箱網の浮子及び沈子の数は夫々 8 個，平面網のそれは 9 個である．

7) **Table III の 15 欄**の h は全沈子が底から離れた時だけが，流体力学的な揚力となり，その他の場合には，流体力学的に働いた揚力は，これよりも小さい．

実験結果の解析

(1) 変形係数 k

網の射影面積と流速との関係は，代表的な網について **Fig. 8, 9** に片対数目盛で図示してある．これは直線で近似できるので，その傾斜を求めた値 k も図中に記入してある．これを式で示すと，

$$\log S = -kV + \text{const.}$$

の形となる．$V=0$ のときの S を S_0 とおくと，この式は，

$$S = S_0 e^{-kV} \quad \cdots\cdots\cdots\cdots\cdots\cdots (1)$$

の形になる．このようにして，従来漁網の抵抗係数の中に含ませていた一要素を，簡単な形で分離することに成功した．

平面網及び真四角な箱網について，流速と射影面積との関係を図示すると，第1図及び第2図のようになる．（図中の k は近似式を用いず (1) 式を用いて得た値である．）

平面網と箱網の k に対する l/D（土俵網の長さ l と，水深 D との比）及び B^*/W との関係を調べると，第3図に示すように，l/D の影響は殆んど認められず，又 B^*/W の系統的な影響も認められない．そして k の値は，平面網が箱網より大きいことも分る．

流れの抵抗を受けた網の形は，一種の懸吊線と見做されるので，後日この見地に立つて，この資料の解析を行う予定である．そしてこの際には，懸吊線の支点に当るところが，移動可能なので，この移動量，即ち変形係数を決定する重要な要素は，網を上下方向に引張る力，$b+d$（**Table III, 12, 13 欄**において，b は水中における浮子の浮力，d は水中における網と沈子の水中重量）と，流れによる抗力 P（**同表 10 欄**，水平分力）との比，又はそれに似た量であると思われる．

(2) 土俵網に働く力の水平分力係数 C_P

C_P と流速との関係は，**Fig. 6–a** 及び **6–b** に示した通りで，この図は左端から順に，土俵網の長さが 60 cm, 90 cm 及び 120 cm の場合を示す．これから得られる結論は，本論文の概要 (3) に述べた通りである．

平面網及び箱網以外の網について，単に全体の平均値を求めることは余り意味が無いの

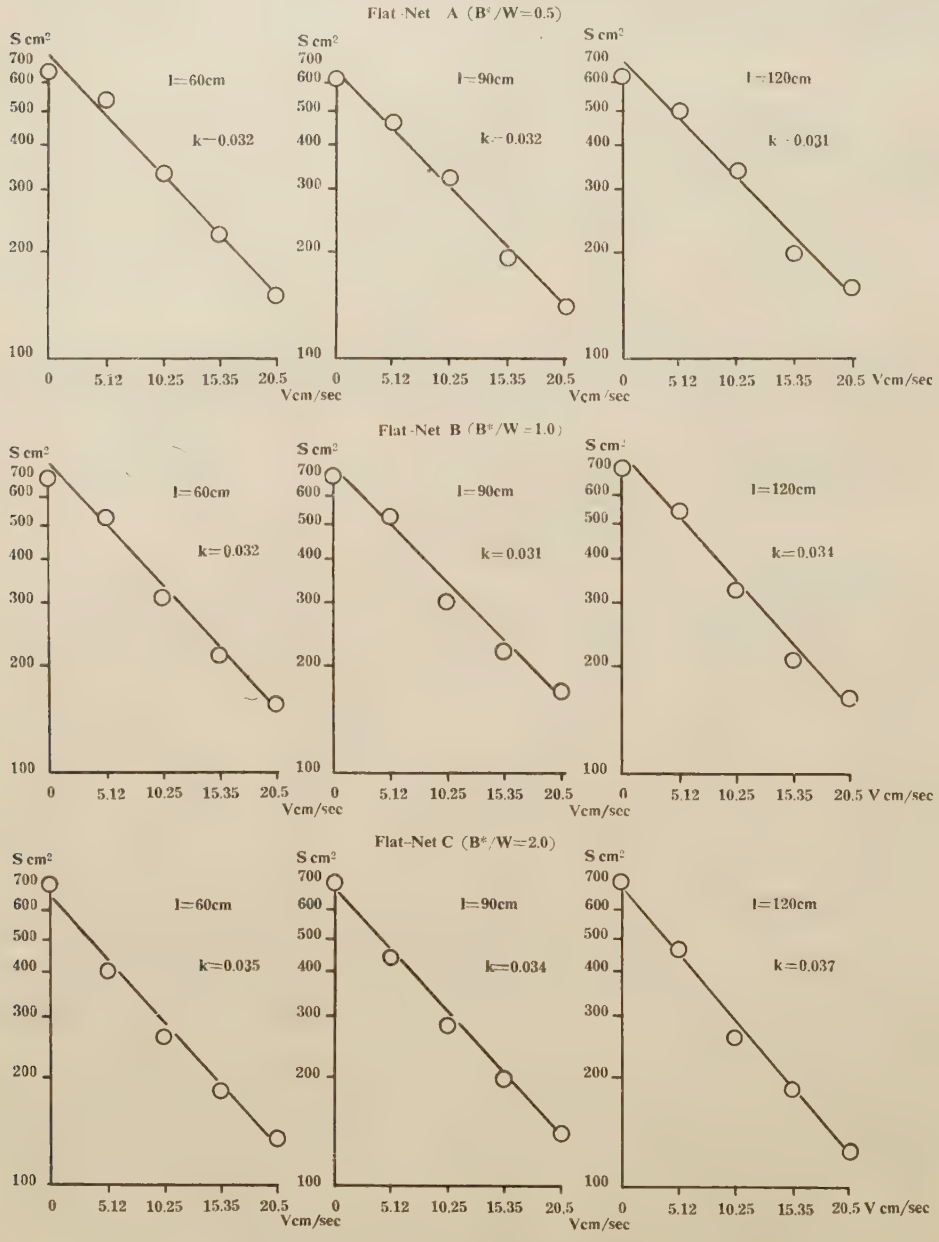


Fig. 1. The relationship between the current velocity and the projected area of flat-nets.

で，全体の傾向をみるために，**Table II** に示した網の型式別（1–a, b 及び 2–b）の C_P と流速との関係を図示すると，第4図のようになる．この結果から次のことが言える．

1) C_P は，同じ網でも流れを受ける方向，即ち ox, $-ox$ 及び oy (**Fig. 2–d** 参照) によつて異る．

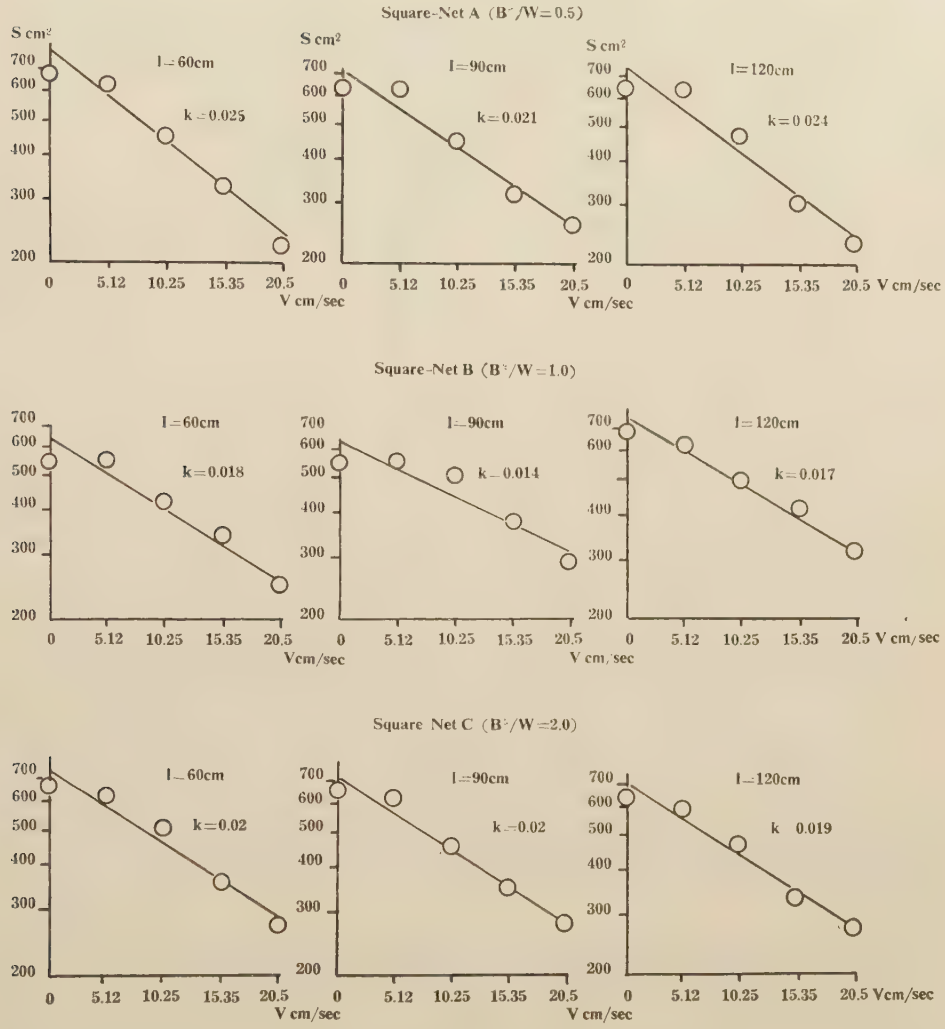


Fig. 2. The relationship between the current velocity and the projected area of square-nets.

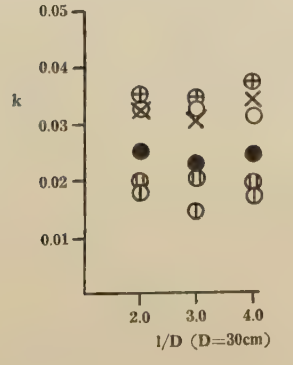


Fig. 3. The relationship between 1/D and the coefficient of deformation.

○…0.5
×…1.0
⊕…2.0
} B*/W, Flat-Net.

●…0.5
◑…1.0
◍…2.0
} B*/W, Square-Net.

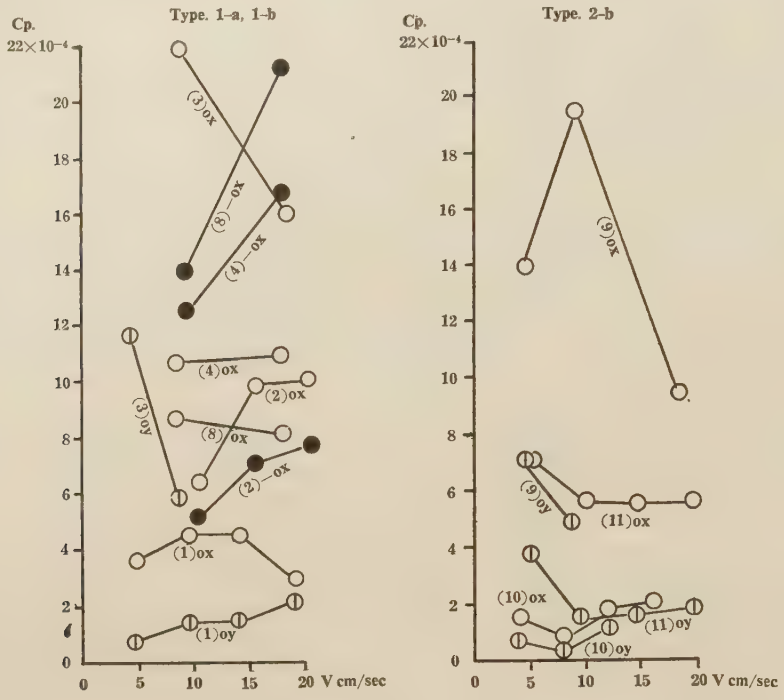


Fig. 4. Horizontal coefficient of models of nets which are in practical use.
Numerals in round brackets ( ) show the name and number of net in Table II ; ox,-ox and oy, show the current direction.

底層式網 (2-b) の C_P は，中層式網 (1-a, 1-b) の C_P よりも概して小さい．

2) 中層式網 (1-a, 1-b) の C_P は，底層式網 (2-b) の C_P に比し，流速による変化の割合が概して大きい．

(3) 網に働く流体力学的な上下方向の力（これを揚力と略称する．）

この力を h^* と定義すれば，

$$h^* \leqq h = Q + d - b$$

(**Table III** において，Q は垂直分力，b は水中浮力，d は水中重量，h は揚力）で，全体の沈子が水底を離れている時にのみ h が全揚力を与えることになる．全体の沈子が水底を離れるのは今回の実験では，平面網の $B^*/W=2.0$ で，流速が 10.25 cm/sec 以上の時，及び箱網の $B^*/W=2.0$ で，流速が 15～20 cm/sec 以上の時である．それ故に，これらの場合には C_h を網の揚力係数とすることができる．この時の揚抗比 C_h/C_P を求めると第3表のようになる．

ここに α は第5図のように網の迎角に相当する角度である．

第3表から次のような傾向のあることが知られる．

1) 平面網の土俵網の長さが異つても，流速が増大すると揚抗比は小さくなり，迎角は小さくなる．

2) 平面網が或る同じ流速を受けるときは，土俵網が長くなれば揚抗比は小さくなり，

第　3　表

Net	l cm	V cm/sec	C_P	C_h	C_h/C_P	α
Flat-Net $B^*/W=2.0$	60	10.25	7.3×10^{-4}	1.6×10^{-4}	0.22	50°
		15.35	8.2	1.8	0.22	30°
		20.50	19.7	3.6	0.19	23°
	90	10.25	7.3	1.3	0.18	50°
		15.35	7.7	1.25	0.16	33°
		20.50	15.8	2.23	0.14	24°
	120	10.25	6.4	1.4	0.22	52°
		15.35	7.8	1.0	0.13	35°
		20.50	18.7	2.66	0.12	24.5°
Square-Net $B^*/W=2.0$	90	20.50	9.2	0.67	0.073	—
	120	15.35	7.7	0.45	0.059	—
		20.50	9.4	0.36	0.038	—

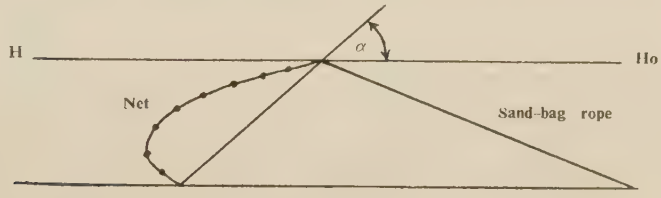


Fig. 5. Angle of attack of the current-deformed net.

迎角は大きくなる．

（4）沈子に働く力

網と水底との間に働く力は，今回は特殊な場合のみについて測定したが，この力を特別に測定しなかつた今回の実験値からも，次のような仮定のもとに，沈子に働く力を求めることが出来る．

1）沈子以外の部分の網と水底との接触部に働く力は無視できる．

2）沈子の位置での網の方向は，静止摩擦角の方向にある．いま一つの沈子に働く水中重力を d_0，i 番目の沈子が網によつて引かれる力を F_i，網と水底とのなす角度を δ_i，沈子と底面との摩擦係数を μ とすると，上記仮定により，

$$\mu\,(d_0 - F_i \sin\delta_i) = F_i \cos\delta_i$$

であるから，

$$F_i = \frac{\mu\, d_0}{\cos\delta_i + \mu \sin\delta_i}$$ となる．

摩擦角を ϕ とおくと，$\mu=\tan\phi$

$$F_i = \frac{d_0 \sin\phi}{\cos(\phi-\delta_i)}$$

これによつて，水底についている沈子の数を n とすれば，水底と接している部分に働く水平力及び下向きの力は，

$$\sum_{i=1}^{n} F_i \cos\delta_i \quad \text{及び} \quad \sum_{i=1}^{n} (d_0 - F_i \sin\delta_i)$$

で求められ，これだけの値の修正を行うことにより，今回の資料から，網にかかる純粋の

流体力学的な力を取り出して，流体力学的解析を行うことができる．このことは，(1) 変形係数の項で述べた事項と共に，別の報告として発表の予定である．

謝　　辞

本論文のとりまとめに当つて，広島大学理学部教授藤原武夫博士，同じく前川力博士より夫々御懇切なる御指導と御校閲を賜り，又鹿児島大学水産学部教授藤田親男博士より数々の御助言を賜つた．茲に深甚の謝意を表する次第である．

Errata of the formerly report

P. 147 Line 17th, For '(b)[4]' read '(b)[14]'; P. 150 Line 18th, For 'thesand-bag' read 'the sand-bag'; P. 152 Line 26th, For '10.1 cm/sec～1.5 cm/sec' read '0.1 m/sec ～1.5 m/sec'; P. 153 Line 23rd, For 'brakets' read 'brackets'; P. 153 Line 29th, For 'conditinos' read 'conditions'; P. 153 Line 33rd, For 'As shown in the former paragraph as shown in Fig 3,' read 'As shown in Fig 3, in each fixed-net, net-deformation changes'; P. 154 156 Table II, Name and characteristics of Net, (4)(5)(6)(7)(8), For 'Middle-Rayer yellowtail Set-Net' read 'Middle-Layer yellowtail Set-Net'; P. 161 Bottom line, For '9 are representative ones', read '9 show the S/V diagram semi-logarithmically plotted'; P. 165 Fig. 4-C. A, For 'a lateral view of 20.5 cm/sec' should be except; P. 175 Line 9th, For 'sand-ropes' read 'sand-bag ropes'; P. 175 Line 21st, For 'component' read 'components'; P. 176 Table V, Colum. At right angle Line 3, and Line 4, For '(4.2)' read '〔4.2〕'; P. 177 Table VI, Colum C_T, For '4.9, 7.6' read '6.3, 10.2'; P. 177 Table VI, Colum C_Q, For '1.9, 1.7, 2.7' read '2.3, 2.1, 2.2'; P. 177 4th lime from the bottom, For 'at the section *b*, in the line of Table III, it is denoted with*;' shoud be except.; P. 177 3rd line from the bottom, For '(Q—B) in the 15th line in negative' read '(Q—B) in the 15th line of Table III is negative'; P. 178 9th line from the bottom, For 'Table II and III' read 'Table III'; P. 178 4th line from the bottom, For 'and its direction ϕ' read 'and in general its direction ϕ'; P. 179 Line 4th, For 'This magnitude decreases' read 'This magnitude increases'; P. 180 Line 4th, For 'through' read thorough'.

Occurrence of Maxima pearl oyster in the Oshima Strait, Amami-Oshima; A northern limit of the distribution

Seiji K. WADA*

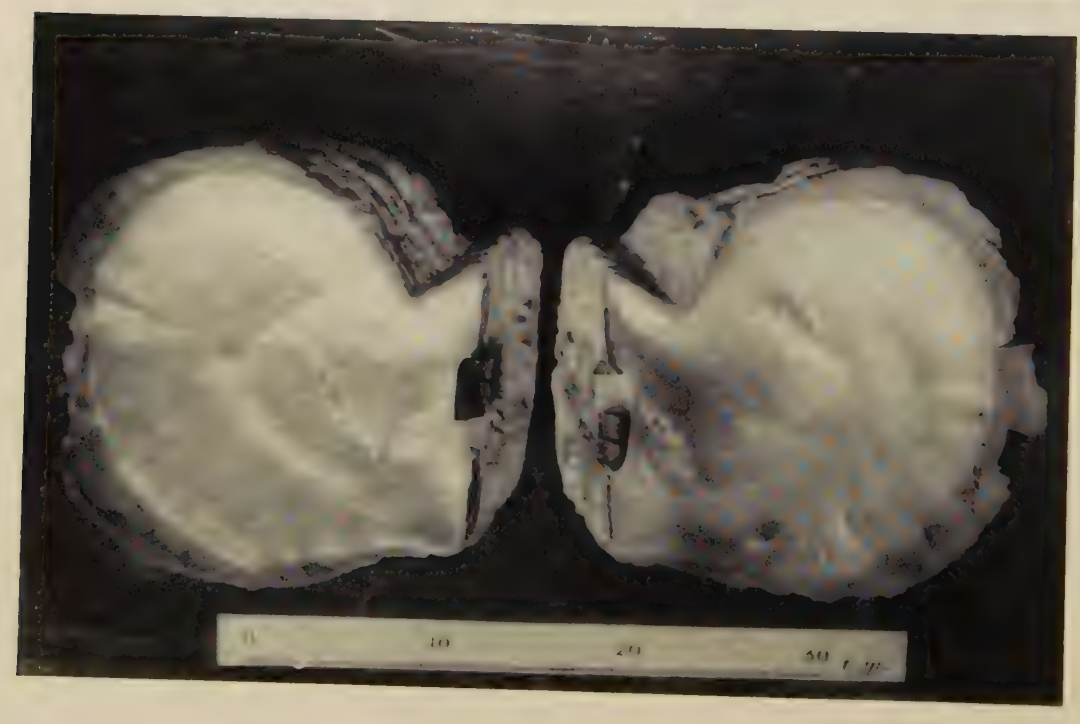
Maxima pearl oyster, *Pinctada maxima* (JAMESON), inhabits coastal waters in the Western Tropical Pacific (JAMESON, 1901). In the North Pacific, the animals are most abundantly distributed around the islands of the Philippines, mainly the Sulu Archipelago (TALAVERA & FAUSTINO, 1931); they are also reported to be found around the Pescadores Islands (TAKI, 1933), the Yaeyama Group of the Riukiu Islands (ODA, verbal communication), and the Palau Islands (WADA, 1941). It seems to have been a general belief among Japanese conchologists that pearl oysters of this species do not inhabit the Japanese territorial waters; for instance, the species is not mentioned in the list of Japanese recent marine molluscs compiled by KURODA and HABE (1952).

The Oshima Strait, located around Lat. 28°10′N and Long. 129°16′E, is a water channel between Amami-Oshima I. and Kakeroma I.; easterly it connects with the Pacific Ocean and westerly opens to the East China Sea.

Occurrence of *P. maxima* in the Strait was for the first time reported by NISHIKAWA in 1904. However, since his report is made only on a specimen exhibited in a commercial fair, the claim cannot be said wholly authentical; he wrote that he was informed the specimen had come from the Satsunan-Seto (the Oshima Strait, hodie). Since then, as far as the writer knows, no authorized report has appeared on the existence of the mollusc in the area, although it seems likely the occurrence has well been known to some local inhabitants.

Recently, after the World War II, two pearl culture companies were established there to produce blister pearls using Pteria pearl oysters which were rather abundantly found in the Strait at that time. Professional divers regularly went to the bottom in search for Pteria. Some local fishermen also ventured frequent dives to gather dumped scrap iron from the bottom. Eventually, several specimens of *P. maxima* have been brought ashore by these means. According to a private communication from Mr. IWAKI who was a technician-in-charge of the Saneku Pearl Culture Co. now liquidated, the company obtained two specimens from the channel. One of the two, collected in 1953, is now kept in the museum of the National Pearl Research Laboratory at Kashikojima, Mie Prefecture. Another specimen, found by a local fisherman in 1955, is kept in the office of the Setouchi Fisheries Cooperation at Setouchi-Machi, Amami-Oshima. The Amami Pearl & Sponge Culture Co. hitherto collected four specimens, one in 1952, another in 1953, and the other two in 1958. One of these four specimens is now deposited at the Oshima Branch Laboratory of the Prefectural Fisheries Experimental Station, Setouchi-Machi, and another in the present writer's laboratory. One of the rest two is kept by the company. Accordingly, seven alive specimens have been obtained since the War. In addition, in 1956 the writer collected one shell-valve on the shore of Yui-Kojima, a small island located in the central part of the Strait. Most of the alive specimens were found on the bottom some 50–60 meters deep in the eastern half of the channel, e.g., off Shokazu, Oshikaku and Tean. Two of the specimens are shown in the photos on the next page.

* From the Faculty of Fisheries, Kagoshima University, Kagoshima-shi, Japan.



Since there is no record of transplantation to the area of Maxima pearl oysters from other localities, it is unequivocal that the animals naturally inhabit the area, and this is the northern limit of distribution* ever known for *Pinctada maxima*.

During his stay at Yui-Kojima I. between 1956 and 1959 to study the artificial propagation of Pteria pearl oyster, the writer had an opportunity to examine four specimens of *P. maxima*, including two alive ones. They are all large in size, ranging from 25 cm to 31 cm in the dorso-ventral measurement, from 24 cm to 26 cm in the antero-posterior measurement, from 6.5 cm to 8.7 cm in the thickness, and from 2 kg to 4 kg in the weight of the shell (two valves together). The inside marginal portion of the shell which is not yet covered by a nacreous secretion is rather broad. The shells generally show a good growth in appearances. Any indication of stunted growth is not discernible even in the largest specimen. It is certain that the molluscs have survived for years in a healthy condition in the Strait. As to the nacre, two specimens are silver-edged and the other two are lightly gold-edged.

Although an annual water-temperature record around the spots where the animals were found is not available, we made a daily measurement of water temperature during the winter months in 1957–1958 in Atetsu Wan, a small inlet facing the main channel. The measurement made at 5 meters under the surface reveals that the lowest water-temperature appeared in the beginning of March, being around 19.5°C. The winter temperature of the main body of the channel water is probably a bit higher than in the inlet. Since in summer the water temperature rises to nearly 30°C, the temperature regime of the channel water seems to be similar to that of the water off the coast of Western Australia (Lat. 25°S) which is believed a southern limit of distribution of *P. maxima* (JAMESON, 1901; HYND, 1955).

MOP shells from Western Australia are generally small in size as compared with those from other localities, the majority not exceeding 20 cm in the dorso-ventral measurement (WADA, 1953a). It is generally believed this is to be attributed to the low winter temperature. Although the number of specimens available is too small to make a general consideration, the great size of the pearl oysters from the Oshima Strait may be said remarkable when the low winter temperature there is taken into account. While the cause of this fact is quite obscure, a similar fact is also found in the size of *Pteria penguin* inhabiting the Strait. The Pteria pearl oysters are also distributed in tropical seas; the northern limit lies at Tanegashima I. (Lat. 30°30′N), not so far from Amami-Oshima. In the Oshima Strait, Pteria measuring 24 cm in the dorso-ventral length are quite common, being markedly larger in size as compared with those from other, more tropical localities (e.g., the Torres Strait).

Although any attempts have not yet made to determine the population density of *P. maxima* in the Oshima Strait, judging from the foregoing accounts on the collection, it is feasible to say that the molluscs are distributed very sparingly on the bottom of the channel. Since the bivalves can reproduce effectively only by mutual stimulation, a successful fertilization *en masse* of discharged gametes can hardly be expected to occur when the animals lie so far apart one another. In other words, it seems unlikely that the population is maintained by the eggs fertilized *in situ*; it is much more likely that the larvae drifted by ocean currents from southern, more densely populated areas would eventually have settled in the channel. The distribution of *P. maxima* in the

* The writer has been informed that a dead shell was found on the western coast of Satsuma Peninsula (Lat. 31° 30′N), Kagoshima Prefecture, and is now kept in a pearl culture company at Koshikijima I. If it is true, this will turn to be the northern limit.

Oshima Strait may be regarded as an example of "sterile distribution". If this is the case, it is supposed to be of rather unusual occurrence; because, if such an event frequently takes place, the pearl oysters would be found more abundantly in the channel.

Distance between the Oshima Strait and the southern part of the Philippines which may be assumed as one of the possible birthplaces of the larvae is about 1,200 nautical miles. With a velocity of 2 knots it takes 25 days to cover the distance. In the time of typhoons which frequently develop in the region in late summer and early autumn, the ocean current would reasonably be expected to shift its usual pattern with a marked increase in velocity. Maxima pearl oysters breed in summer months but the time of breeding may be extended further on occasions (WADA, 1941, 1953b). Working on *P. maxima* at Thursday Island in the Torres Strait between 1958 and 1960, the present writer succeeded in growing several hundred oysters from the fertilized eggs up to spat in glass jars (As to the culture experiments of the pearl oysters, a more precise report will be published later). Most of the larvae settled down as spat in 4 to 5 weeks. It would not seem entirely improbable that the larvae can travel a long distance in case a fortunate coincidence takes place between the time of spawning and the development of a peculiar type of local and ocean currents.

It should also be noted that the molluscs have been found only in the Strait and not around other islands in the southern vicinity. A similar situation has been observed in the Palau Islands, the West Carolines, where *P. maxima* are distributed near the west entrance of and, mainly, in a channel (called Toahel Mid by the natives) between Babeldaob I. and Korror I. and nowhere else in the lagoon and neighboring islands (WADA, 1941). Such a restricted distribution may have some correlation with the pattern of water flow peculiar to a narrow strait.

In any way, there is no doubt that *P. maxima* can grow in a healthy condition in the Oshima Strait. From an industrial point of view, the bivalves are very important; as well known, the valves are extensively used as mother-of-pearl and the cultured pearls they produce are highly esteemed. When the cultivation of the molluscs is successfully accomplished, a big industry would develop there. The low water temperature in winter months may rather favor the production of pearls of good quality.

The writer is happy to express his indebtedness to Mr. I. SHINMURA of the Kagoshima Prefectural Fisheries Experimental Station for valuable information and for making measurements and photos of the specimens; and to Mr. S. KOZUKA of the Amami Pearl & Sponge Culture Co. for kindly placing the specimens at the writer's disposal and for the assistance in various ways.

Summary

1. *Pinctada maxima* inhabits the Oshima Strait (Lat. 28°10′N; Long. 129°16′E), where the water temperature will go down to about 20°C in winter. This is the northern limit of the distribution for the species.

2. In the Strait, the molluscs, though yet found very sparingly, survive for years in a healthy condition, growing to a large size. This suggests a possibility of cultivation in the area of this economically important animal.

3. It would seem likely that the animals have come from the southern, more densely populated area, drifted by currents in their larval stage. Culture experiments show the free swimming period extends 4 to 5 weeks or longer, which may be long enough to explain the aberrant distribution.

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北限分布地である奄美大島，大島海峡のシロチョウガイ

和田清治

要　約　大島海峡（北緯 28°10′）には僅かながらシロチョウガイ *Pinctada maxima* (JAMESON) が生息する．採取された貝はすべて大形のもので良い成長を示していた．生息数は極めて少いと考えられるので，そこで発生したものでなく，海流等の極めて特異な条件の時に偶々幼生が漂着したものであろう．幼生の浮游期間は飼育実験の結果から 4～5 週間と推測される．大島海峡はこの種類の分布の北限であり，冬期水温は 20°C 前後になるが，シロチョウガイが長期間健康な状態で生息していることから，この産業的に重要な貝の養殖に我が領土内唯一の適地となる可能性がある．

On the early development of phyllosomas of *Ibacus ciliatus* (von SIEBOLD) and *Panulirus longipes* (A. Milne EDWARDS)

Toshio SAISHO* and Kantaro NAKAHARA**

In summer of 1960, the writers suceeded to raise the phyllosomas of a scyllarid lobster, *Ibacus ciliatus*, and a spiny lobster, *Panulirus longipes*, up to the fourth stage in glass jars.

As the food of larvae, early nauplii of brine shrimps were used in the same way as adopted by NONAKA *et al.* (1958). Although the first stage larva of *I. ciliatus* has been described in detail by HARADA (1958), there are no information as to the following stages. As far as we know, no reports have appeared as to the larval development of *P. longipes*. In the present paper the early development of *I. ciliatus* and *P. longipes* will be described.

The authors wish to express their gratitude to Dr. Sadahiko IMAI of Kagoshima University for his constant guidance in the course of this work. Thanks are also due to Mr. Seiji WADA of the same university for his kind guidance in making the manuscript.

1. Ibacus ciliatus (von SIEBOLD) (Fig. 1. A–D)

On April 19th and June 4th, we obtained the newly hatched phyllosomas of *I. ciliatus* at the Sakurajima Aquarium in Kagoshima Prefecture. The parent animals had been kept about a week in the aquarium tank. A rather good result was obtained in the second batch. The record of ecdyses during the culture is shown in Table 1.

Table 1. Record of ecdyses during culture (*I. ciliatus*)

Date		1st stage		2nd stage		3rd stage		4th stage	
		living	dead	living	dead	living	dead	living	dead
June	4 [1]	20	—	—	—	—	—	—	—
	14	10	4	6	—	—	—	—	—
	15	2	6	12	—	—	—	—	—
	16	0	6	14	—	—	—	—	—
	24	0	6	6	6	2	—	—	—
	25	0	6	3	6	5	—	—	—
	26	0	6	1	7	5	1	—	—
	28	0	6	0	7	6	1	—	—
July	2	0	6	0	7	5	1	1	—
	3	0	6	0	7	3	2	2	—
	4	0	6	0	7	1	4	2	—
	6	0	6	0	7	1	4	1	1
	8	0	6	0	7	0	5	1	1
	10	0	6	0	7	0	5	0	2

Water temperature: 23.5°–28.4°C

1) Larvae hatched out in the aquarium tank. Twenty larvae were divided into four vessels.

In this batch, as shown in the table, the first ecdysis took place in ten to twelve days after hatching-out, mostly within eleven days. The second ecdysis occurred in

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Table 2. The measurements of larvae of *I. ciliatus*.

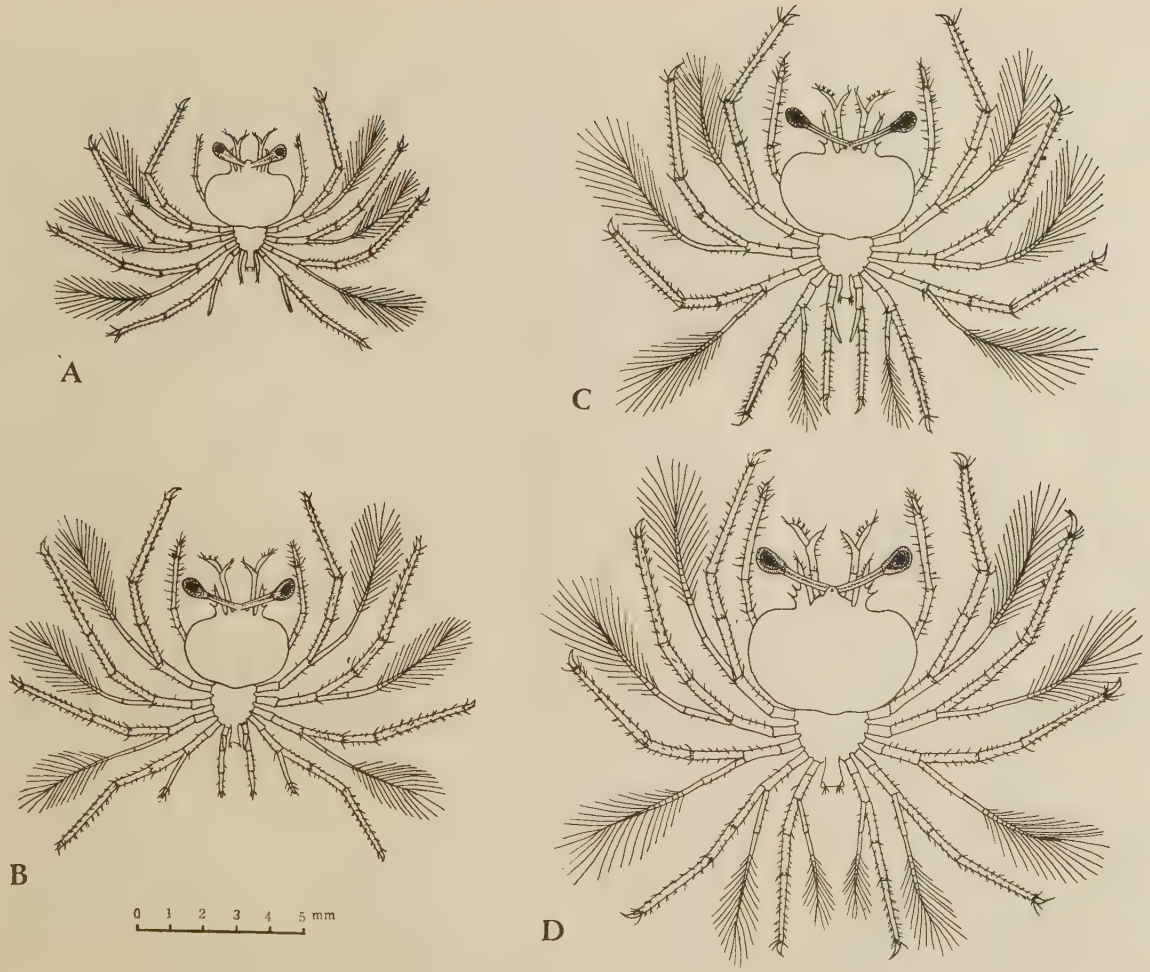
	1st stage[1)]	2nd stage[2)]	3rd stage[3)]	4th stage[4)]
Body length	3.05 mm	3.70 mm	4.54 mm	6.00 mm
Length of forebody	1.75	2.40	2.67	3.72
Width of forebody	2.26	2.85	3.74	5.48
Abdomen length	0.53	0.65	0.63	0.80
1st antenna	1.13	1.46	1.93	2.37
2nd antenna	0.53	0.66	0.87	1.20
Eye length	0.93	1.73	2.05	2.53
1st leg	5.00	6.40	8.35	10.60
2nd leg	4.56	6.95	8.80	11.25
3rd leg	5.10	6.45	8.05	9.90
4th leg	4.00	5.48	6.40	8.92
5th leg	0.73	2.05	3.73	5.60

1), 2), 3) Average of five individuals. 4) Average of two individuals.

Table 3. Main developmental changes of *I. ciliatus* larvae.

	First stage	Second stage
Body length	2.75–3.21 (av. 3.00) mm	3.48–3.76 (av. 3.71) mm
Forebody	1.70 (*L*), 2.26 (*W*) mm	2.40 (*L*), 2.85 (*W*) mm
Abdomen	0.53 mm in length; no segmentation.	0.62 mm in length; appearance of five incomplete partitions on ventral side.
Eye	club-like shaped, not stalked.	development of stalk, separated from the eyeball by a partition.
1st antenna	long, bifurcated at the tip.	the outer branch of the tip separates by a partition.
2nd antenna	bifurcated, the two branches equal in size.	the inner branch becomes larger than the outer one.
Exopod of 4th leg	bud-like, one segment, with 2–3 setae at the tip.	larger than the 1st stage, one segment, 3–4 setae at the tip.
5th leg	bud-like, one segment, with 2–3 setae at the tip; lacking in the exopod.	four-segmented, with small exopod on the 1st segment; exopod bud-like.

	Third stage	Fourth stage
Body length	4.50–4.67 (av. 4.54) mm.	6.10–6.02 (av. 6.06) mm.
Forebody	2.67 (*L*), 3.74 (*W*) mm.	3.72 (*L*), 5.48 (*W*) mm.
Abdomen	0.64 mm in length; five segments are complete ventrally.	0.8 mm in length; appearance of 4 pairs of primordial pleopods on ventral side.
Eye	eyestalk forming a complete segment.	same in shape as the previous stage.
1st antenna	main body consists of 2 segments.	same in shape as the previous stage.
2nd antenna	the inner branch much larger than the outer one.	another short, spine-like branch develops on the outer side.
Exopod of 4th leg	10–12 setae of the distal part arranged feather-like.	well developed feather-like exopod as that of the 3rd leg.
5th leg	five segments; exopod two-segmented, 3–4 setae at the tip.	five segments; exopod with 7–8 feather-like setae at the distal part.



A. The first stage.
B. The second stage.
C. The third stage.
D. The fourth stage.

Fig. 1. (A—D) Phyllosomas of *Ibacus ciliatus.* (dorsal view)

twenty to twenty-four days after hatching-out. Two individuals underwent third ecdysis which took place in twenty-eight and thirty-four days respectively after hatching-out. The measurements of each stage are shown in Table 2. Also, main points of developmental changes from the first stage through the fourth stage are shown in Table 3.

For the first stage larvae, readers are referred to the detailed description of HARADA (1958). In his report, HARADA describes that the fifth legs of the larva are composed of four segments with a budlike exopod on the second segment. On the contrary, in the first stage larvae of the above-stated two batches, the fifth legs are not segmented and exopod cannot be recognized (Fig. 1. A). The cause of this discrepancy remains to be solved.

2. Panulirus longipes (A. Milne EDWARDS) (Fig. 2. A–D)

The newly hatched phyllosomas were obtained at the same aquarium on August 1st. The first stage larvae are small in size than those of *I. ciliatus*. They are as a whole similar both in size and shape to those of *P. longipes* which are described by NAKAZAWA (1917), KINOSHITA (1931), and NONAKA *et al.* (1958). A morphological difference of the phyllosoma between *P. longipes* and *P. japonicus* lies in the number of segments of the third leg. According to NAKAZAWA (1917), the first stage larvae of *P. japonicus* have the six-segmented third legs. But the third legs of *P. longipes* are composed of four segments, while a very rudimentary bud-like exopod is attached to the middle part of the second segment (Fig. 2. A). The record of culture is shown in Table 4.

Table 4. Record of ecdyses during culture (*P. longipes*).

Date		1st stage		2nd stage		3rd stage		4th stage	
		living	dead	living	dead	living	dead	living	dead
Aug.	1[1)]	102	—	—	—	—	—	—	—
	8	23	67	12	—	—	—	—	—
	9	16	69	15	2	—	—	—	—
	10	4	72	22	4	—	—	—	—
	11	1	73	24	4	—	—	—	—
	12	0	74	24	4	—	—	—	—
	16	0	74	11	10	7	—	—	—
	17	0	74	8	11	8	1	—	—
	18	0	74	4	14	6	4	—	—
	19	0	74	2	15	6	5	—	—
	20	0	74	1	16	5	6	—	—
	24	0	74	0	17	3	7	1	—
	25	0	74	0	17	2	8	1	—
	28	0	74	0	17	1	8	2	—
	29	0	74	0	17	1	8	1	1
Sept.	5	0	74	0	17	0	9	1	1
	11	0	74	0	17	0	9	0	2

Water temperature: 23.0°–28.0°C

1) Larvae hatched out in the aquarium. 102 larvae were divided into five vessels.

In this batch, as shown in the table, twenty-eight out of a hundred and two larvae underwent the first ecdysis which took place in eight to eleven days after hatchout, mostly within ten days. The second ecdysis occurred in sixteen to twenty days after hatchout, in the majority within eighteen days. The third ecdysis took place in twenty-four to twenty-nine days after hatchout.

The measurements of each stage and main developmental changes from the first stage through the fourth stage are shown in Table 5 and Table 6 respectively.

Table 5. The measurements of each stage larvae of *P. longipes*.

	1st stage[1)]	2nd stage[2)]	3rd stage[3)]	4th stage[4)]
Body length	1.20 mm	2.06 mm	2.13 mm	2.54 mm
Length of forebody	0.87	1.30	1.46	1.60
Width of forebody	0.73	1.02	1.09	1.14
Abdomen length	0.25	0.27	0.29	0.31
1st antenna	0.47	0.70	0.78	0.86
2nd antenna	0.33	0.47	0.55	0.67
Eye length	0.57	0.90	0.97	1.20
3rd maxilliped	2.05	2.13	2.40	2.55
1st leg	3.48	3.60	3.80	4.13
2nd leg	3.30	3.34	4.40	5.22
3rd leg	2.93	4.27	4.90	5.45
4th leg	—	—	—	0.13

1), 2), 3) Average of five individuals. 4) Average of two individuals.

Table 6. Main developmental changes of *P. longipes* larvae.

	First stage	Second stage
Body length	1.17–1.23 (av. 1.20) mm.	2.01–2.10 (av. 2.06) mm.
Forebody	0.87 (*L*), 0.73 (*W*) mm.	1.30 (*L*), 1.01 (*W*) mm.
Abdomen	0.25 mm in length, no segmentation.	0.27 mm in length, no segmentation.
Eye	club-like shape, not stalked.	eyestalk separates from the eyeball by a metameric partition.
1st antenna	no branch, 3 small setae at the tip.	same in shape as the previous stage.
2nd antenna	no branch, shorter than the 1st ant. 2–3 small setae at the tip.	same in shape as the previous stage.
3rd maxilliped	five-segmented, developed exopod on the 2nd segment with 4–6 setae at the distal part.	larger exopod with 8–10 setae at the distal part.
3rd leg	the longest leg, 2 times as long as body length; The exopod, very small, on the 2nd segment.	appearnce of a partition at the base of exopod; 2–3 setae at the tip of exopod.
4th leg	lacking.	lacking.

	Third stage	Fourth stage
Body length	2.08–2.17 (av. 2.13) mm.	2.50–2.58 (av. 2.54) mm.
Forebody	1.46 (*L*), 1.03(*W*) mm.	1.60 (*L*), 1.14 (*W*) mm.
Abdomen	0.28 mm in length no segmentation.	0.31 mm in length, four incomplete partitions appear on ventral side.
Eye	a partition appears at the base of the stalk.	same in shape as the previous stage.
1st antenna	a partition appears at the base.	same in shape as the previous stage.
2nd antenna	a partition appears at the base.	same in shape as the previous stage.
3rd maxilliped	same in shape as the previous stage.	same in shape as the previous stage.
3rd leg	the exopod is two-segmented, with 4–6 setae at the tip.	9–10 setae on the distal part of 2nd segment of exopod arranged feather-like.
4th leg	lacking.	the primordium appears.

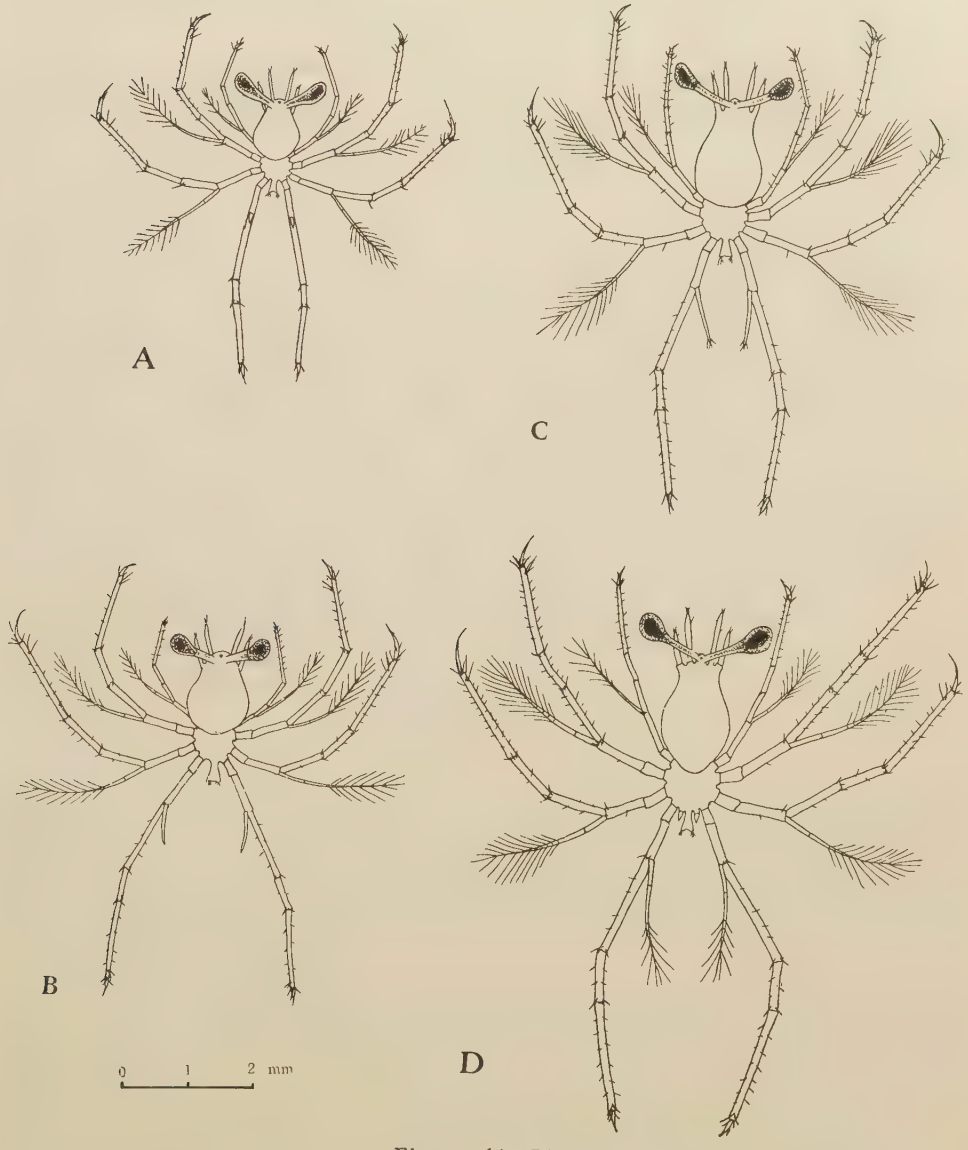


Fig. 2. (A—D)

The dorsal views of phyllosomas of *Panulirus longipes*.

A. The first stage.
B. The second stage.
C. The third stage.
D. The fourth stage.

Summary

1. Early four stages of *Ibacus ciliatus* and *Panulirus longipes* larvae are described. The newly hatched-out larvae were reared in the laboratory.

2. Some notes on the culture of phyllosomas of two species are presented.

3. In the course of the development, the fourth and the fifth legs in *Ibacus ciliatus* and the third and the fourth legs in *Panulirus longipes* undergo profound changes.

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Studies on Some Marine Algae from Southern Japan, III

Takesi Tanaka

Recently, marine algal surveys were made by the writer around the islands of Southern Japan; Amami Islands, Tanegashima and Yakushima, Uji Islands, Tokara Islands and others. Furthermore, on board the training ship of our Faculty of Fisheries, other surveys were executed in the Ryukyu Islands, twice in 1957 and 1959.

The result of the investigation seems to the writer, to be of interest and may contribute, to some extent, to the further study of the marine algal flora of the southern parts of Japan and also of the Ryukyu Islands. Among the specimens of marine algae from these islands, collected by the writer since 1947, there are many interesting ones, some of which are described in the following pages.

Certain specimens of these were taken to the University of California in 1958 and were compared with those kept in the Herbarium of that University.

Here the writer wishes to express his most sincere thanks to Prof. G. F. Papenfuss of the University of California for his valuable suggestions and kind guidance. Thanks are also due to Mr. Koji Nozawa, Assistant Professor and Mr. Yuzo Hayashida, Assistant of our Faculty, and Mr. Yasushi Nakamura, Officer of our training ship, the Keitenmaru, for their help and co-operation in this research.

This is intended to be an article for the memorial publication of Prof. Yukio Yamada and Hajime Matsuura's sexagenary birthday anniversary.

Punctaria mageshimensis Tanaka, spec. nov.

Pl. I, A, Pl. II, A. and Text-fig. 1.

Frons foliacea, subcoreacea, perforata, altitudine major 40 cm alta, 280–450 μ crassa, stipite brevissimo, irregulariter ramosa; laminis latioribus infra saepe lobularis, supra 2-3-chotomis: segmentis ultimis plus minus ligulatis; cellulis laminaris 4–5 stratosis, duabus vel triabus mediis multo majoribus quam corticalibus, illis 100–170 μ his 40–55 μ altis; cellulis corticalibus parietalibus tenuibus, a superficie visis 4–5–angulatis, 15–28 μ diam.; sporangia solitaria vel 2–3 aggregata, subglobosa vel obovata, 90–150 μ diam.; colore fulvo vel lurido.

Japanese name. Goanme.

Habitat and localities. Mageshima Island, Tanegashima (Col. Aug. 14th, 1959 and Aug. 10th, 1960). The plants were collected by Mr. Yazo Goan from about 20 meter's depth at rocky bottom.

Frond broadly foliaceous, subcoreaceous, more or less perforate, 40 cm in height, 280–450 μ in thickness, somewhat stupose at the base, ending below in short stipes, irregularly ramified, lower part of the blade often lobular, but often dividing di-to trichotomous in upper part; ultimate segments more or less ligulate; blade consisting of 4–5 layers of cells, of which the cells in the inner layers much larger than those of the cortical layers, measuring 100 μ to 170 μ diam. for the former and 40 μ to 55 μ for the latter; cortical cells 4–5 sided in surface view, 15–28 μ in diam.; sporangia usually solitary, sometimes 2–3 together aggregate, subglobose or obovate, 90–150 μ in diam.; colour of the frond brown or dirty brown.

This large, broad *Punctaria* is very distinct and characteristic of large size species. In this present new species, the blade is ramified in a peculiar and irregular manner.

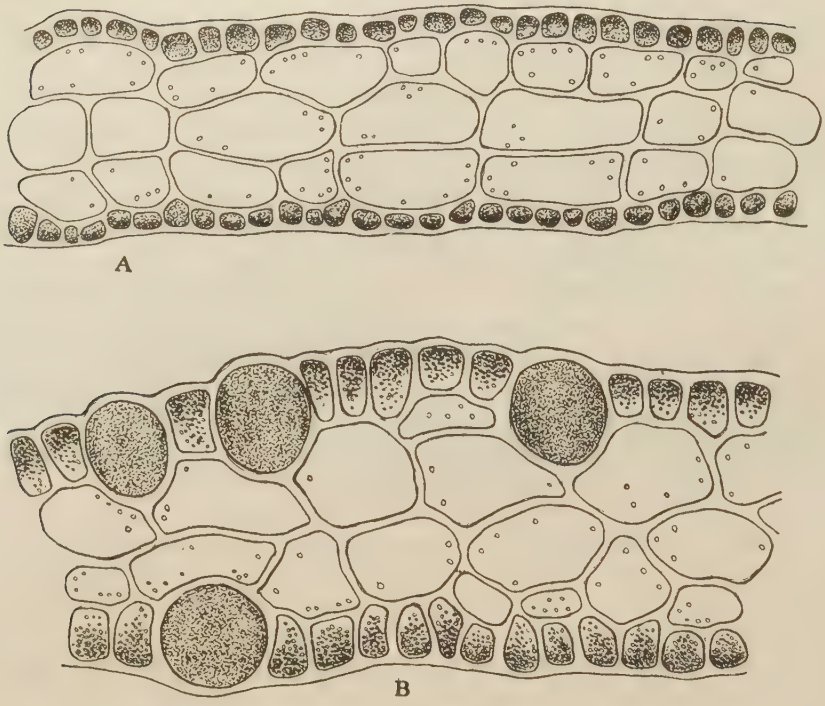


Fig. 1. *Punctaria mageshimensis* Tanaka.

A. Portion of a cross section of the young frond. ×150. B. Portion of a cross section of the frond, showing sporangia. ×150.

Therefore, this is distinguishable from the other species of *Punctaria*, in its having a blade which is ramified at the above portion into di-to trichotomous. The base of the frond is generally simple and somewhat broadly cuneate, but is often lobular marginally. The perfarations do not so often appear in young plants, but are abundantly found in the old. The sporangia are scattered promiscously on both sides of the frond, in single or small groups. The hair and paraphyses are usually absent.

The Japanese name for the above species is Goanme. after Mr. Yazo Goan, a fisherman of Mageshima Island, to whom I give my hearty thanks for his help and kindness to the writer.

Trematocarpus pygmaeus Yendo v. *elongatus* Tanaka, var. nov.

Pl. I, B. and Text-fig. 2.

Frons pulvinatim caespitosa, 3–5 cm alta, 0.5–0.8 mm lata, radice nodoso implicata, parce dichotoma, ramulis ad basin leviter subcomplanata, ramis ramulisque saepe teretiusculis in parte superiore, ultimis ramulis elongatis et plus minus acutis; cystocarpiis globosis vel subglobosis infra apicem ramulorum inflatis; colore bruneo-rubro vel luteo-rubro; substantia subcoreacea.

Japanese name. Hoso-mianagusa.

Habitat and localities. Mageshima Island, Tanegashima (Col. July 5th, 1950). Growing on rocks in the lower littoral zone.

Frond erect, pulvinate-caespitose, subcoreaceous, 3–5 cm high, 0.5–0.8 mm broad,

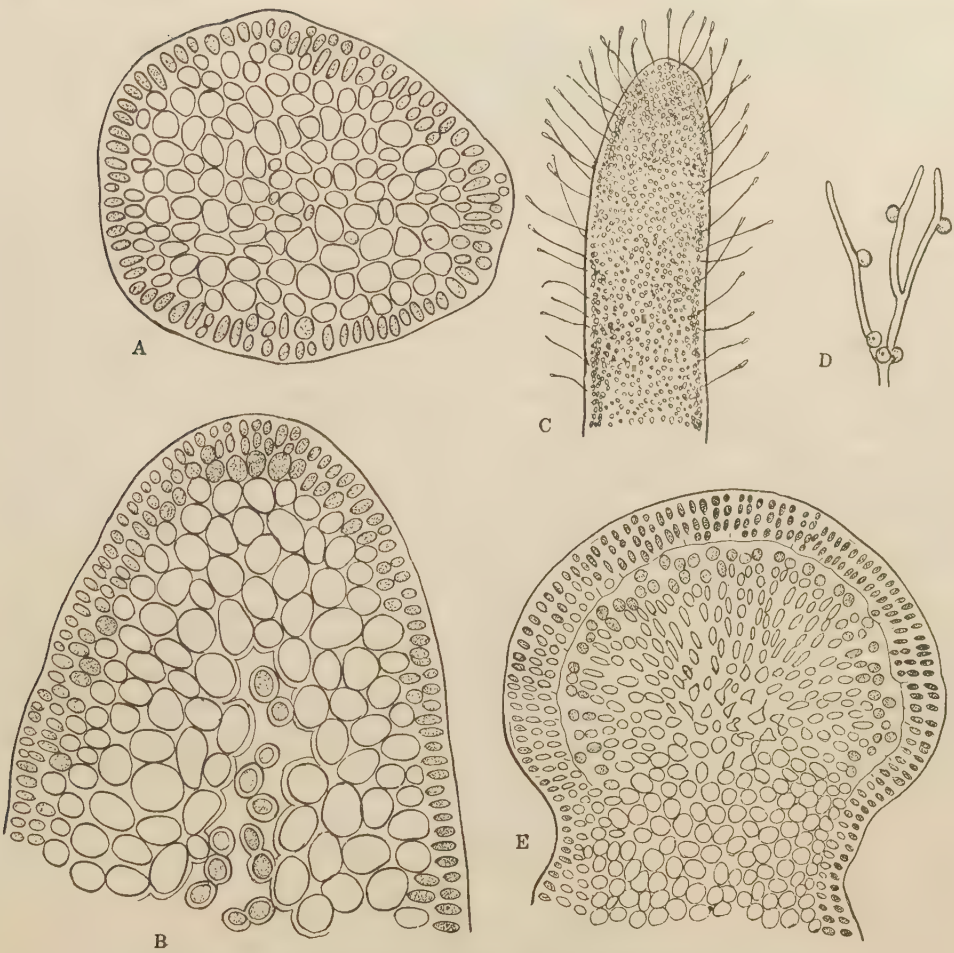


Fig. 2. *Trematocarpus pygmaeus* YENDO *v. elongatus* TANAKA.

A. Cross section of a young frond. ×250. B. Cross section of a frond. ×450. C. Apex of a ultimate branchlet, showing colourless hairs. ×50. D. A portion of the cystocarpic ultimate branchlets. ×2.5. E. cross section of a cystocarp. ×450.

forming a globular tuft, standing a short subcylindrical stem from a callus disc, more or less dichotomously branched, branches usually subcomplanate below, ultimate branchlets elongate and cylindrical, often with colourless hair-like cells; proliferous branches very few and not so developed; medullary tissue consisting of loosely packed, elongated, vertically oblong small cells, with diameter of ca. 17 μ; cortical layer consisting of 2–3 layers of coloured cells, intermediate, of a dense layer of larger roundish cells, glandular cells absent; cystocarps almost globose or subglobose, sessile, on the surface of the upper part of the branchlets; colour of the frond brownish red or yellowish red.

YENDO, in 1920 first described *Trematocarpus pygmaeus* which was found in Nomo, Nagasaki. Later it was also reported by OKAMURA in his Icones of Japanese Alage, Vol. V, pl. 243, figs. 1–8 (1927). The writer got the chance of comparing his specimens with OKAMURA's authentic materials collected from Misaki, preserved at the Herbarium

of the University of California.

In general appearance, the present new variety can be differentiated from the other by its shape and the size of the ultimate branchlets.

Hypnea yamadai TANAKA, spec. nov.
Pl. II, B, and Text-figs. 3–4.

Frons intricato-caespitosa, 4–10 cm alta, subcomplanata, teres ad apicem 0.7–2 mm crassa, irregulariter alternato-ramosa, pleurumque ramo principale percurrenti; ramis alternis ramulos breves horizontales gerentibus, subpaniculatibus; ramulis ultimis ramosissima, apice abrupte obtusis aut attenuatis acutis; cellulis internis magnis, ad superficiem diminuendis, omnibus hyalines, strato superficiali parvis cellulis coloratis unistratosis composito; parte incrassata lenticulata cellularum medullarum non adeunte; tetrasporangiis in partibus tumidus ramulorum ultimorum gerentibus; cystocarpiis et antheridiis ignotis; colore pulchere rubro; substantia membranacea.

Japanese name. Beni-ibaranori.

Habitat and localities. Uji Islands (Col. May 30th, 1953); Koshikijima (Col. June 10th, 1959); Tomioka, Amakusa (Col. June 19th, 1959); Shimoda, Izu; Tanabe, Kii. Growing on rocks in upper sublittoral zone.

Frond intricate-caespitose, 4–10 cm high, subcomplanate, somewhat subcylindrical towards the apex, 0.5–2 mm broad, irregularly alternate ramified, principal axis more or less percurrent, branches mainly standing at almost right angle to the axis; upper branches subcylindrical and not so intricate, 0.5–1.5 cm high, 0.7 mm thick, irregularly much branched and more or less subpaniculate; ultimate branches spinous or obtuse at the apex; cells of the inner layer, excepting central axis, large, gradually smaller towards periphery; lenticular thickening in the walls of the medullary cells absent;

Fig. 3. *Hypnea yamadai* TANAKA.
Habit of a fertile plant. ×2.

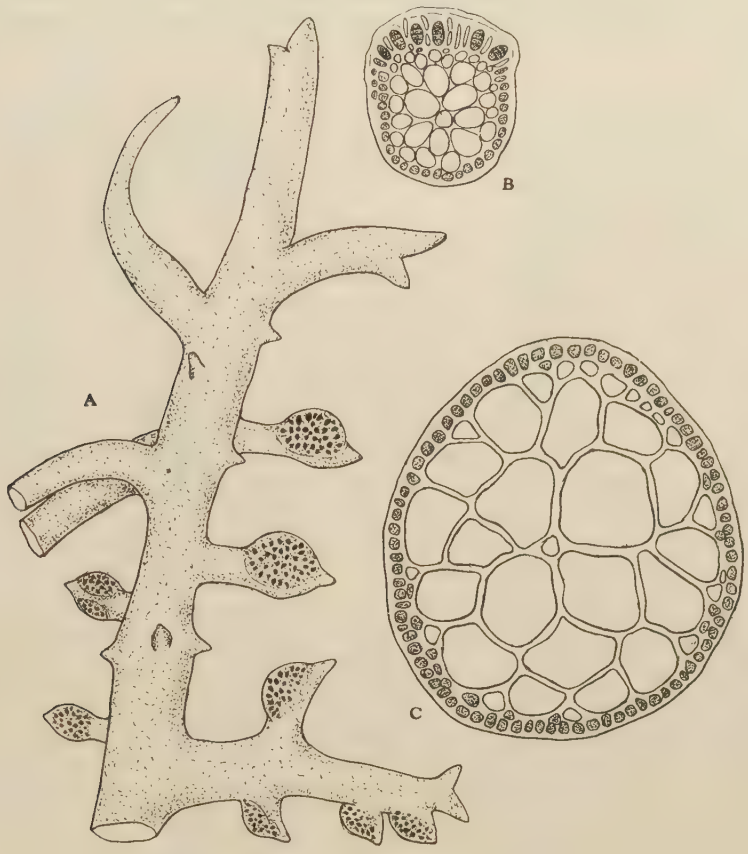


Fig. 4. *Hypnea yamadai* TANAKA.

A. A portion of a tuft showing the upper stichidial branches. ×20. B. Portion of the cross section of the stichidia. ×250. C. Portion of the cross section of the lower frond. ×250.

tetrasporangia on one side (afterwards gradually around) of the swollen part of the ultimate branchlets, tetraspores irregularly zonate, 16–20 μ×28–36 μ; cystocarps and antheridia unknown; colour of the frond pretty red; substance membranaceous.

The present plant of *Hypnea* is a rather special one among the Japanese *Hypnea* species. In general appearance, this has some resemblance to H. *cervicornis* J. AG., but differs from it in its ramification and in the shape of the branchlets. *Hypnea yamadai* belongs to the Section Spinuligerae. This species is distributed widely in the warmer parts of Honshu and Kyushu, Japan.

Dictyopteris fucoides TANAKA, spec. nov.

Pl. III, and Text-fig. 5.

Frons ad 35 cm altitudine, foliacea, subcoreacea, 3–4es regulariter dichotoma, stipitata; stipite longo, ad basin stuposo, 2–5 cm longo, ca. 1.8 mm diam., raro diviso;

segmentis subcuneatis, 1.5–3.4 cm latis; membrana in supra parte 4–5 stratosa, 240–300 μ crassa, in infra ad partim mediam 6–7 stratosa, ad 540 μ crassa; soris oogonialibus in

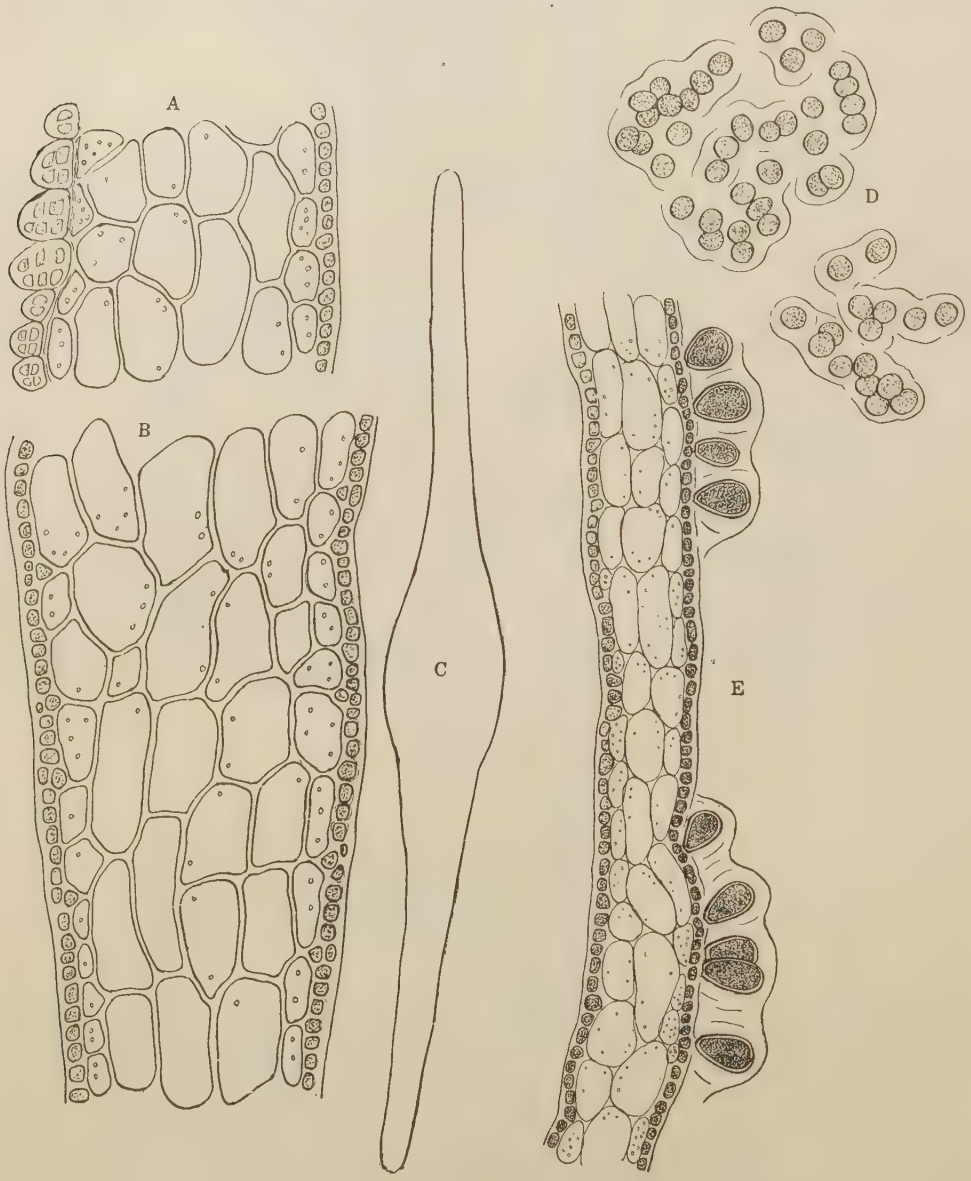


Fig. 5. *Dictyopteris fucoides* Tanaka.

A. Portion of the cross section of the antheridial frond. ×450. B. Portion of the cross section of the lower branches ×450. C. Cross section of a frond ×20. D. Oogonial patches seen from above. ×250. E. Portion of the cross section of the female frond, showing the oosporic sorus. ×250.

superficie unaque laminae irregulariter lateque evolutis; oogonia aggregata, ellipsoidea vel obovata, 40–46 $\mu \times 65$–85 μ; antheridia cuboidea, ca. 65 μ alta, 75 μ lata; colore brunneo vel umbrino.

Japanese name. Ooba-yahazu.

Habitat and localities. Funauke, Iriomote Island, Ryukyu Islands (Col. Oct. 25th, 1959); Koniya, Amami Islands (Col. Oct. 18th, 1959); Mageshima Island and Nishinoomote, Tanegashima (Col. Aug. 20–25th, 1960). Dredged from 20–40 meter's depth off a rocky or coral bottom.

Frond exceeding 35 cm in height, foliaceous, 3 or 4 times regularly dichotomous, stipitate; stipe rather long, subterete, 2–5 cm long, about 1.8 mm thick, one or two times regularly ramified, with remnants of the marginal membranes attached, segments subcuneate, 1.5–3.4 cm wide, 240–300 μ thick; midrib relatively broad, distinct in the middle part of the frond, consisting of 4–5 layers above, increasing to 6–7 layers in the lower part and about 540 μ in thickness; stalks continued into the blade and its divisions as definite though distinct midribs which divide notably far down in advance of the divisions of the blade, so that two forkings of the midribs occur before the first corresponding division of the margin; oogonial sorus scattered, in groups of 4–10, ellipsoidal or obovate, 40–46 $\mu \times 65$–85 μ, usually only on one side surface of the frond; antheridia nearly cubic, ca. 65 μ broad, and 75 μ high; colour of the frond brown or dark brown and black on drying.

This new species is very distinct. In point of size, this stands in the same rank, with *Dictyopteris justii*, *D. anstralis*, *D. melleri*, *D. membranaceous*, *D. cokii*, *D. diaphana* TAYLOR etc. Among these species of *Dictyopteris*, the shape of the present species resembles the figures of *Haliseris Justii* (LAMX.) KG., in Tabulae Phycologicae, vol. 9, no. 55, but can be distinguished from those figures by the shape of blades and also by the situation of the sorus. The sorus are developed on only one side of the blade, occupying almost the whole surface of the frond, except the midribs, according to the writer's examination. The segments are rather broad, mostly subcuneate, and are more than 1.5 cm in width.

Dictyopteris papenfussii TANAKA, spec. nov.

Pl. IV, B. and Text-fig. 6.

Frons ad 15 cm altitudine, delicata, foliacea, membranacea, ad basin stuposa, sparse dichotomeque ramosa, furcatae intervalis 2–3 cm angulisque angustatis; segmentis linearis vel lineari-spathulatis ad apicem plus minus obtusis, 4–6 mm latis, 80–100 μ crassis; membrana crassitudine duarum cellularum in parte stipites 6–7 stratosa, ca. 350 μ crassa; sorus ignotis; colore aureo-fusco.

Japanese name. Ribon-yahazu.

Habitat and localities. Shodon, Kakeroma Island, Amami Islands (Col. May 25th, 1954).

Frond to 15 cm high, somewhat foliaceous, regularly dichotomous, membranaceous, sparingly branched, stalk-like base narrow and stupose, gradually expanding to about 4 mm in width below the first forking, branches dichotomous, often unequal, at intervals of 2–3 cm; angle below narrow acute or slightly rounded, in the upper portion 45°–60° and a little rounded; segments linear or linear-spathulate, usually same width, 4–6 mm broad, 2–3 cm long, consist of two layers of cells, together measuring 80–100 μ, in thickness; midrib relatively narrow, distinct in the whole part of the frond, consist of 6–7 layers of cells; reproductive organ unknown; colour of the frond golden brown.

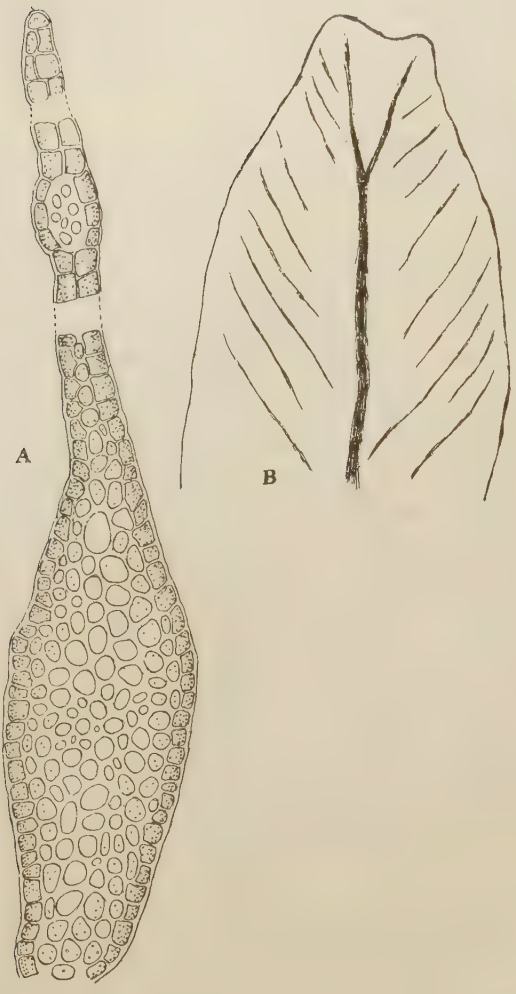


Fig. 6.

Dictyopteris papenfussii Tanaka.

A. Portion of the cross section of the frond. ×250.

B. Portion of the ultimate branchlet, showing the midrib and indefinite side ribs. ×20.

Generally, the present species is allied to *Dictyopteris delicatula* Lamx., but differs from it in its longer segments and in its narrow angle of branching. And also, this very delicate *Dictyopteris* has a taller and broader thallus than. *D. repens* Okam. The thallus consists of two layers of cells, with the exception of the ribs in the middle and sides of the frond where the ribs are composed of several layers of thick wall cells, measuring 350 μ in total thickness. The hair grow on one side of the thallus. In this plant, there are no creeping fibers from the under surface of the thallus, according to the writer's examination.

Galaxaura yaeyamensis Tanaka, spec. nov.

Pl. IV, A. and Text-fig. 7.

Frons arborescentes, ca. 9 cm lata, regulariter dichotomo-ramosa, stipitata; stipes subteretis, dichotomis, velutinos; internodia complanata, plus minus canaliculata, 0.5 cm longa, 2.6–3.5 mm lata, 240–320 μ crassa, calce forte incrassata; tela assimilatoria e cellularum stratis tribus contexta, ca. 75 μ crassa; cellulis epidermalibus angulatis in

aspectu, superficiali, circiter ca. 20 μ diam.; cellulis papillosis minutes, 12–14 μ latis, 30–40 μ longis, solum ad margines; colore albo-roseo.

Japanese name. Usuyuki-garagara.

Habitat and localities. Funauke, Iriomote Island, Ryukyu Islands (Col. Oct. 25th, 1959); Nishinoomote, Tanegashima (Col. Aug. 25th, 1960). Dredged from 20–30 meters depth at coral bottom.

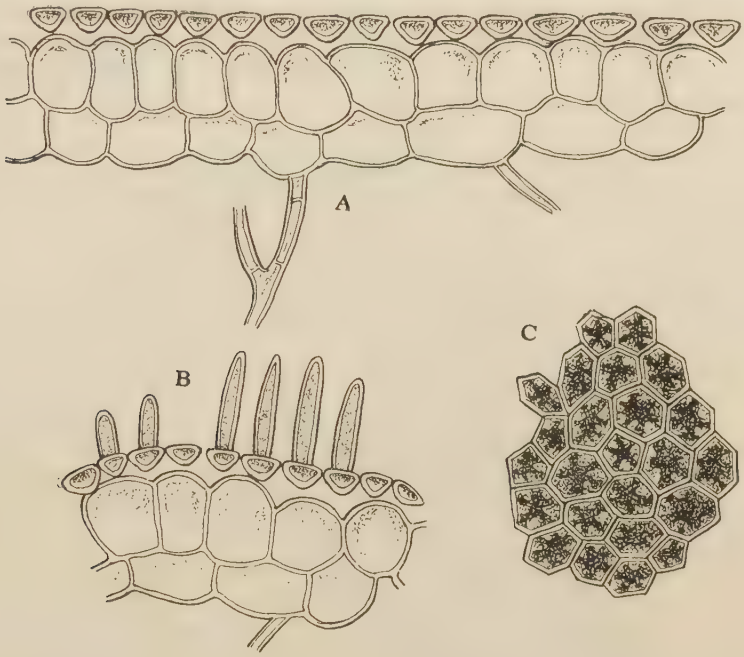


Fig. 7. *Galaxaura yaeyamensis* TANAKA.

A. Section of the frond to show tristromatic cortical cells. ×200. B. Portion of the cortex from the margin, showing the spinulose cells. ×250. C. Epidermal layer seen from above. ×450.

Frond arborescens, 9 cm high, regularly dichotomous, strongly calcified, stipitate; stipe long, cylindrical and velvety, about 4 cm long, 3 mm in diam., giving rise cuneately to the complanate blades; internode complanate, and more or less canaliculate, 0.5–2 cm long, 2.6–3.5 mm wide, and 230–320 μ thick, without any striations on the surface of the internode, apices blunt and rounded, scarcely taperd; medullary filaments ramifying very rarely, entangleing in a irregular manner, about 15 thick; cortex consisting of three layers of cells, parenchymatic, and about 50–75 μ in thickness; epidermal cells consisting well developed stellate chromatophores, lens-like or obconical in cross section, but but 5–6 gonal when seen from surface, 20 μ in diam.; papillate processes very rare, small, 12–14 μ × 30–40 μ, usually aggregated only at the marginal portion of the frond; reproductive organ unknown; colour of the frond reddish white.

The present species is allied to *Galaxaura vetnamensis* DAWSON in its general characteristics, but differs from it in its somewhat well developed stipe, and in its tristromatic cortical tissue. It bears some resemblance also to *G. elegans* TANAKA, having a well developed stipe, but, in this species, the width of the frond is broader than that of *G. elegans* TANAKA.

Padina stipitata TANAKA et K. NOZAWA, spec. nov.
Pl. V, A. B. and Text-figs. 8–10.

Frons 3–12 cm alta, 80–100 μ crassa, longe stipitata, flabelliformis, plerique 3 stratosis cellularum, ad basin saepe 4 stratosis composita; stipites cylingraceo-teretis, 2–3.5 cm longo, 0.6–0.8 mm diam.; parenchymaties, ad basin plus minus discalis pilloso adfixis; segmentis flabellatis, subfissus, margine integris, membranaceis; zonis interpilaribus latioribus, ca. 3 mm latis; calce leve incrassatis; sori tetras orangiorum ad quamque zonam interpilarem irregulariter dispositi, indicio contecti; sporangia obovata, 40–60 μ $\times$45–70 μ; colore flavido, autem postea brunneo.

Japanese name. Etuki-umiuchiwa.

Habitat and localities. Funauke, Iriomote Island, Ryukyu Islands (Col. Oct. 25th, 1959); Koniya, Amami Islands (Col. Oct. 19th, 1959). Dredged from 25–40 meter's depth at coral bottom.

Fig. 8.
Padina stipitata TANAKA et K. NOZAWA.
Habits of the matured plants, showing inrolled and not-inrolled marginal portions. $\times$1.5.

Frond 3–12 cm high, 80–100 μ thick, flabellate, provided wtih a long stipe, often dividing into many small segments in old, composed of three layers of cells, but often four toward the base; stipe very long, cylindrical, 2–3.5 cm long, 0.6–0.8 mm diam., composed of parenchymatic tissue, basal part of the stipe somewhat disc, hairy, often divided; segments flabellate, membranaceous, entire or often shallowly split at the margin, incrusted very slightly with chalk on the dorsal surface; interpilar zones rather wide, about 3 mm in width; sori of tetrasporangia usually produced on the upper side

of every hair-line on the ventral surface, making a discontinous line, provided with a well marked indicium; sporangia usually obovate, densely gathered in irregular roundish sori, 40–60 $\mu \times 45$–70 μ; colour of the frond yellow, but yellowish brown in old.

The most clearly distingushing characteristics of Padina stipitata is that it is a clearly stipitate species among the genus. This stem-like stalk is usually divided into two portions, namely, the base segment which is short hairy and the other one which is long and cylindrical. The hairy part is more or less discoidal and is often divided several times. The long stem-like portion is straight and not ramified, reaching the length of no less than 3.5 cm.

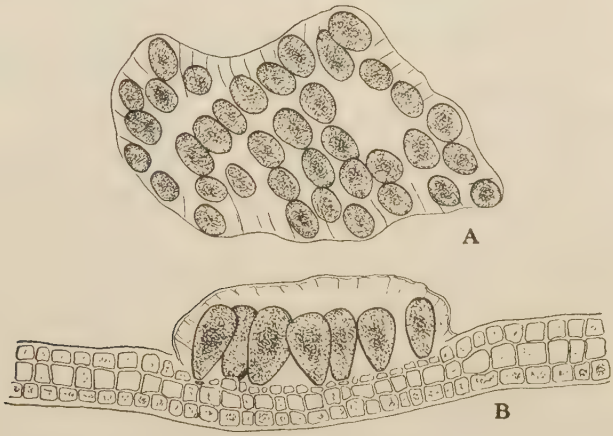


Fig. 9. *Padina stipitata* TANAKA et K. NOZAWA.
A. Sorus seen from the surface of the frond. ×200. B. Vertical section through a sorus. ×250.

Structually, the stalk consists of parenchymatic tissue, and medullary layers consists of somewhat vertically elongated cells. The marginal part of the frond is always inrolled, showing the characteristic of genus *Padina*, but in its old stage, this margin often disappeared, showing the general appearance like Section Zonarieae of Dictyotaceae. The frond consists of three layers of cells, but often of four layers in the lower part of the frond. At the surface layer of the ventral side, the frond is covered with very thin chalk, the surface cells of which store the more developed chromatophores than those on the dorsal surface. The cells of the medullary layers are larger than those of the cortical cells, showing a square or rectangular figure in cross section. The tetrasporangial sorus range concentrically on the middle parts in every interpilar space. Tetrasporangia are irregular, usually obovate in shape, with remarkably clear indicium.

Rosenvingea intricata (J. AGARDH) BOERGESEN

Fig. 11.

Marine Algae Danish West Indies, vol. 1 (1914) p. 182, Some Marine Algae from Mauritius II (1941) p. 65; TAYLOR Plants of Bikini and Northern Marshall Islands (1950) p. 97, Pacific Marine Algae Allan Hancock Foundation to the Galapagos Islands (1945) p. 83; DAWSON, Mar. Algae Gulf of California (Allan Hancock Pacific Expedition, vol. 3, no. 10, 1944) p. 233, pl. 52, fig. 1, An annotated List Marine Algae Eniuetok Atroll, Marshall Islands (Pacific Science, vol. 9, 1957) p. 111, fig. 15.

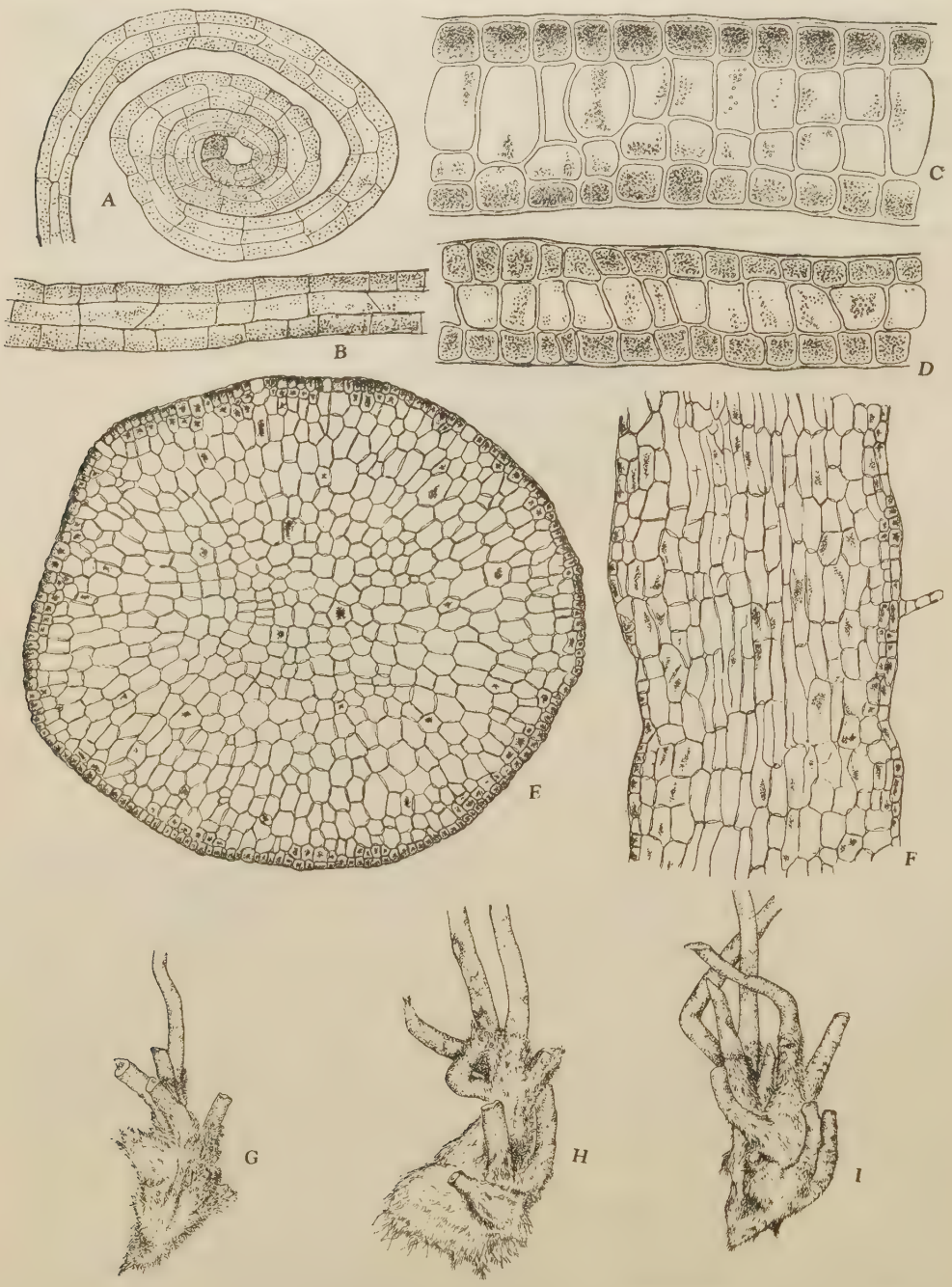


Fig. 10. *Padina stipitata* Tanaka et K. Nozawaa.

A. Radial lomgitudinal section of the marginal portion. ×250. B. portion of the vertical section of the young frond ×250. C. Portion of the vertical section of the frond. ×450. D. Portion of the vertical section of the lower part of the frond. ×450. E. Portion of the cross section of the stipe. ×100. F. Fortion of the vertical section of the stipe. ×50. G, H, I. Basal parts of the stipes. ×6.

Syn. *Asperococcus intricata* J. AG., Nya Alga från Mexico (1847) p. 137, Spec. Alg., vol. 1 (1848) p. 77; WEBER VAN BOSSAE, Liste des Algues du Siboga (1913) p. 137.

Syn. *Encoelium intricatum* KUETZ., Spec. Alg. (1849) p. 551, Tab. Phycol., vol. 9, tab. 5.

Japanese uame. Mosa-kudafukuro.

Habitat and localities. Nishinomote, Tanegashima (Col. Aug. 24th, 1960). Dredged from 25 meter's depth off Sandy Bottom.

Distribution. Mexico, Gulf of California; India; Marshall Islands, Bikini; Galapagos Islands, Bikini; Galapagos Islands; Ecuador; Barbadoes.

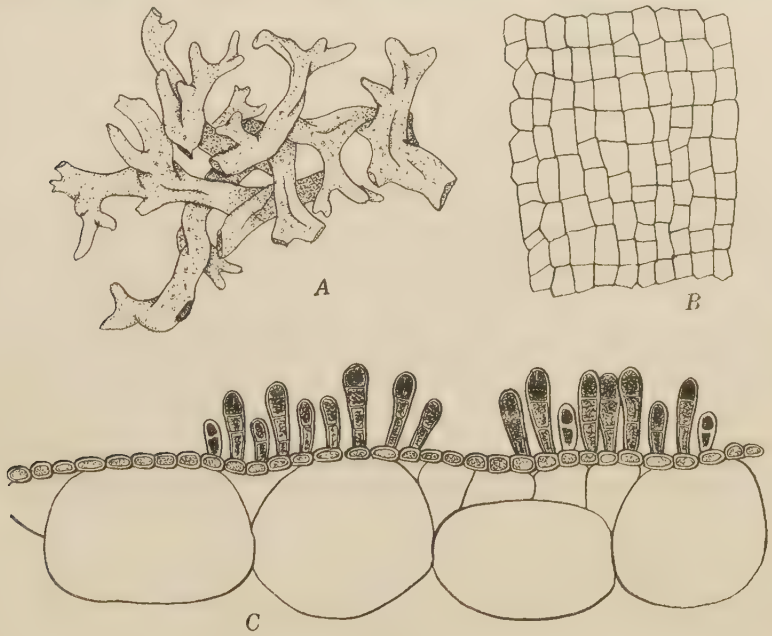


Fig. 11. *Rosenvingea intricata* (J. Ag.) BOERGESEN.

A. Habit of part of a plant. ×20. B. Surface cells. ×250. C. Transection of a thallus through a sorus of plurilocular sporangia. ×250.

Frond small, to 3 cm tall, bushy, intricate, membranaceous, much and very irregularly dichotomously branched, terete or subcomplanate, hollow, about 1–1.5 mm wide below, about 0.5 mm above, but the tips obtuse, marked by minute darker sori; frond wall 70–100 μ thick, consisting of a single surface layer of small, somewhat periclinally elongated, densely pigmented cells mostly 10–13 μ in length, and a subsurface tissue of thin-walled, rounded, colourless cells up to 80 m in diameter; gametangia unaccompanied by paraphyses or hairs, 20–30 μ long, 7–9 μ diameter; colour of the frond yellowish brown.

The writer has been able to examine the Mexican specimens of *Rosenvingea* from Gulf of California, collected by Dr. E. Y. DAWSON. In outer appearance and anatomical structure of the frond, our plants fairly agree with the Mexican ones. In the specimens at hand, however, the frond is more slender and more intricate than those of the Mexican ones. This plant is here reported for the first time in Japan.

In 1954, the writer collected, at Kakeroma Island, Amami Islands, small fragments

of *Rosenvingea*, which is assumed by the writer to be *Rosenvingea orientalis* (J. Ag.) Boergesen.

和 文 摘 要

日本南海産海藻類の研究（其三）

田　中　　剛

日本南海の奄美群島，屋久島，種子島，宇治群島，トカラ列島等の諸島の海藻類については，筆者は茲 10 年間継続調査研究中である．更に 1957 年及び 1959 年の 2 回，沖繩諸島の海藻の調査を行う機会を得た．これらの調査による採集品中には学術上興味深いものが多数あり，これらの研究は今後に俟つものが多いが，今回はそのごく一部を茲に発表したいと思う．

この研究を行うに当り，種々研究上の援助を与えられた，米国カリホルニア大学のパーペンフス教授に深甚なる感謝の意を表したいと思う．更に又海藻採集に助力された，本学，野沢助教授，林田補手及び本学練習船敬天丸，航海士中村靖君に感謝の意を表する次第である．

この報告は筆者の恩師，北海道大学，松浦　一，山田幸男両教授の還暦記念出版の一編としたいと思う．

ゴアンメ：体長 40 cm を越える長大なハバモドキ属の一新種で，体は多少の分岐が見られ，馬毛島周辺の深海に生育する．和名は本植物の最初の発見者，後庵弥蔵氏に因んで命名した．

ホソミアナグサ：これも馬毛島周辺に生育するミアナグサの一変種で，体の小枝及び末小枝が細長く，円柱状を呈するので，ミアナグサと区別出来る．

ベニイバラノリ：本州中南部の太平洋岸，九州西南部に広く分布するが，体の外観が他のイバラノリとは異なつている．美しい紅色を呈するイバラノリの一種である．

オーバヤハズ：体長 35 cm を越える長大なヤハズグサの一新種で，藻体は古くなると相当厚くなり，黒褐色を呈し，一見ヒバマタの如き外形となる．沖繩，西表島，船浮，奄美六島，古仁屋，及び馬毛島等の深海（20～40m）に生育する．

リボンヤハズ：繊細なヤハズグサ属の一種で，全藻体に等幅の葉片を有し，縁辺全縁で，波縮しない．ヒメヤハズと多少似ているが，体が長いのと葉片の様子が異るので区別される．奄美大島，加計呂麻島，諸鈍産．

ウスユキガラガラ：ガラガラ属植物中，*G. vetnamensis* Dawson, ヒメガラガラと近似の種と思われるが，長茎を有する事と皮層細胞が 3 層である事で，*G. vetnamensis* と異なる．又体に横紋がない点と石灰質の厚層の点とでヒメガラガラと差異がある．沖繩，西表島，船浮及び種子島，西之表の深海より採集．

エツキウミウチワ：茎状の長柄を有する特種のウミウチワの一新種である．体は殆んど

3層より成るが，体の下部では4層になる事もあり，子嚢群は各毛線間帯に形成せられ，皮膜を存する．沖繩，西表島，船浮及び奄美大島，古仁屋の25～40mの深海からドレッジにて採集されたもの．

モサクダフクロ：種子島，西之表海岸の25mの海底よりドレッジにて採集したもので砂質の所に他の海藻と混生している．筆者は先年米国カリホルニア大学腊葉室に所蔵される *Rosenvingea* 属の種類を調査する事が出来たが，本種は *Rosenvingea intricata* (J. Ag.) Boergesen と査定出来ると思う．メキシコ産のものに比して藻体が細く，枝及び小枝がもつと互に錯綜している．尚，奄美大島，加計呂麻島，諸鈍にて1954年採集した他の *Rosenvingea* 属の一種は *Rosenvingea orientalis* (J. Ag.) Boergesen と思われる．

A. *Punctaria mageshimensis* Tanaka. ×2/5.
B. *Trematocarpus pygmaeus v. elongatus* Tanaka. ×2/3.

A

B

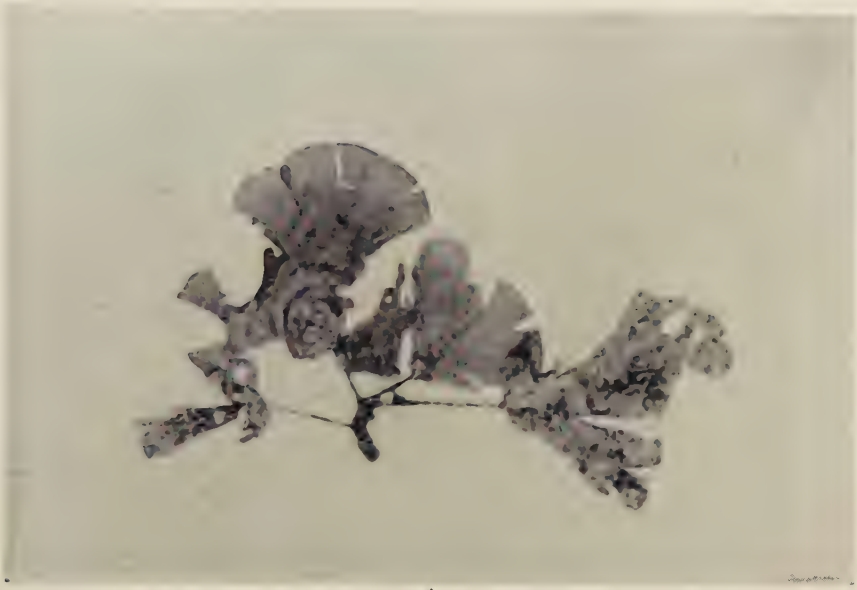
A. *Punctaria mageshimensis* Tanaka. ×2/5.
B. *Hypnea yamadai* Tanaka. ×1.

A, B. *Dictyopteris fucoides* Tanaka. × 1/2.

A

B

A. *Galaxaura yaeyamensis* Tanaka. ×2/3.
B. *Dictyopteris papenfussii* Tanaka. ×1/2.



A

B

A, B. *Padina stipitata* Tanaka et K. Nozawa. ×2/3.

One Red Algal Parasite from Japan

Takesi TANAKA* and Yuriko NOZAWA**

Four genera (*Corallina*, *Jania*, *Prionitis* and *Callophyllis*) of Cryptonemiales have been reported as host plants of red parasitic algae. In 1959, one red parasitic plant on *Carpopeltis angusta* (HARV.) OKAM. was newly collected at Hananose, near Mt. Kaimon, Kagoshima Prefecture by the writers.

This parasitic plant grows scattered over the stem and branches of the host plant, forming a somewhat ceranthus or hemiconfetto shape in the matured ones. The frond consists of wartlike basal and of somewhat columnar branches. The colour varies from

Fig. 1. *Kintokiocolax aggregato-cerantha* TANAKA et Y. NOZAWA.
Habit of parasitic plants on *Carpopeltis angusta* (HARV.) OKAM. ×1.

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Fig. 2. *Kintokiocolax aggregato-cerantha* Tanaka et Y. Nozawa.

Fig. Portion of the cross section of the matured female plant, showing many cystocarps.

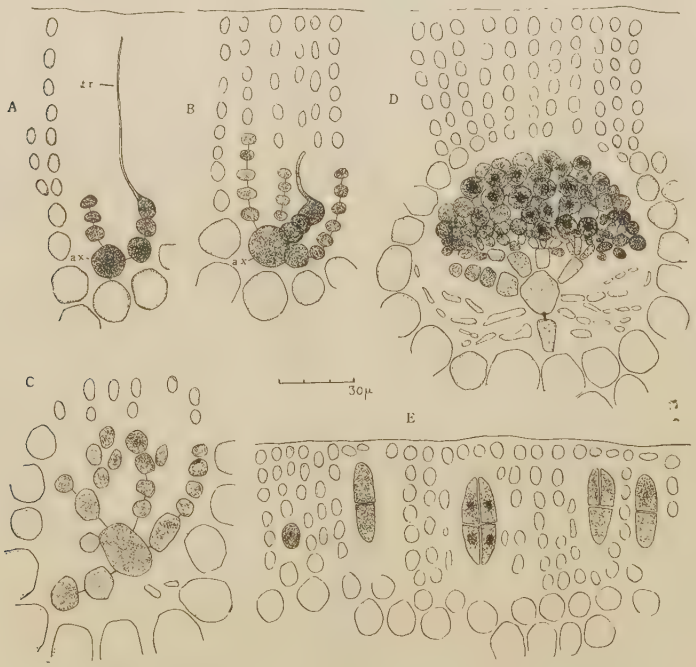

Fig. 3. *Kintokiocolax aggregato-cerantha* Tanaka et Y. Nozawa.

A. Matured carpogonial branch (tr. Trichogyne, ax. Auxiliary cell.). B–C. Carpogonial branch after fertilization (ax. Auxiliary cell). D. Immatured cystocarp. E. Portion of the cross section of the frond of tetrasporic plant, showing tetrasporangia.

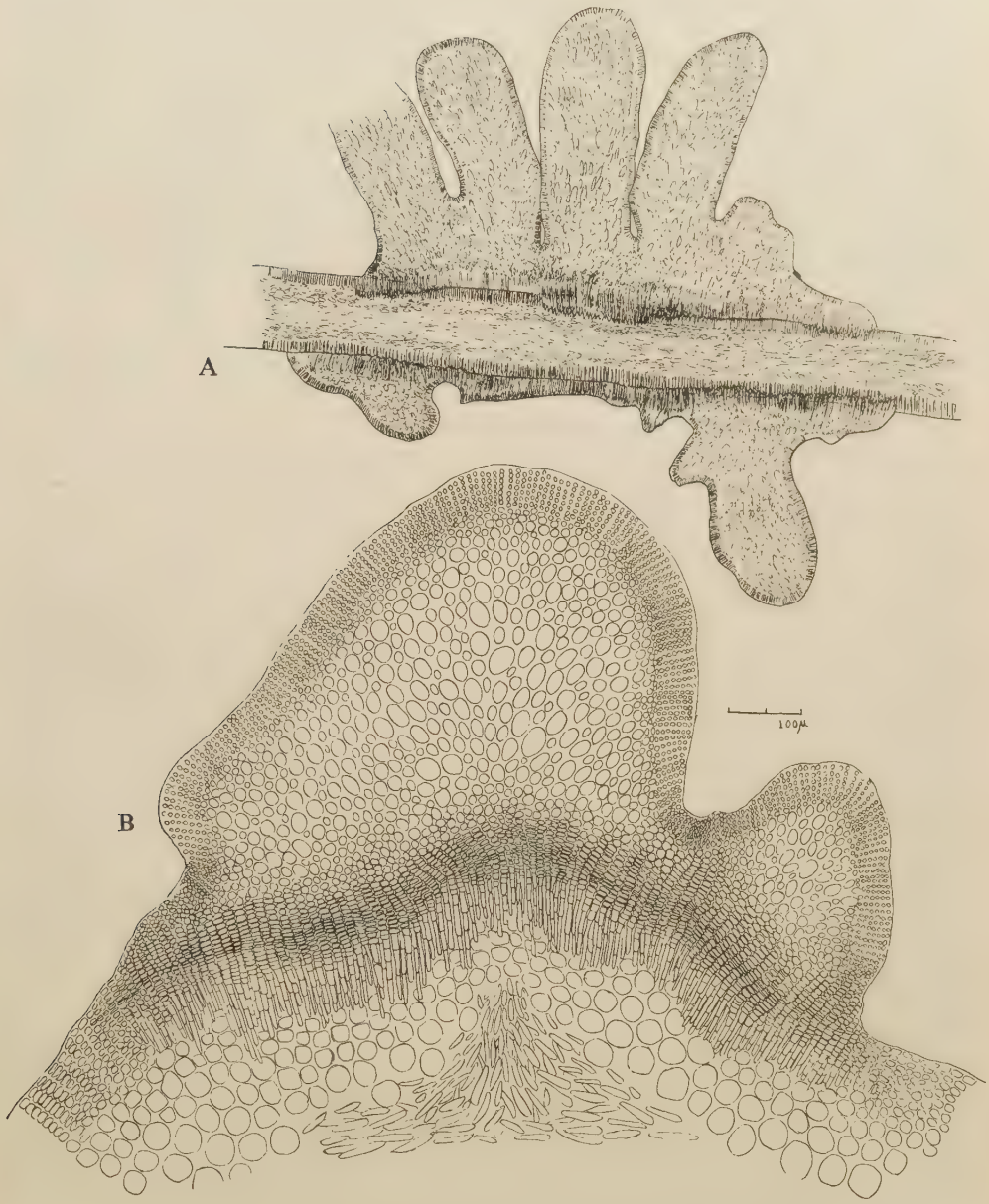

Fig. 4. *Kintokiocolax aggregato-cerantha* TANAKA et Y. NOZAWA.

A. Portion of the transverse section of the fronds. ×20. B. Portion of the transverse section of frond, showing the rhizoidal filaments penetrate into the cortical tissue of the host plant. ×100.

light reddish yellow to purplish red. The surface of the frond is smooth, and the substance is rather cartilagenous. The plant attaches to the host plant by its rhizoidal filaments or by its flattened basal layer. The penetration of the host occurs by means of slender, rather long rhizoidal cell filaments which deeply penetrate to the cortical layer of the host plant.

As for the anatomical structure, the thallus consists of the cortical and the medullary tissues. The medullary tissue is formed with rather parenchymatic filaments composed of large and elongate, often dichotomously branched, cylindrical cells. When seen from the cross section, the medullary tissue is observed to be parenchymatic. The cortical tissue seen in cross section is composed of short, 6–7 vertical cell-rows. Each outermost of medullary tissue is directly connected with two cells of cortical tissue at its outer side.

The tetrasporic or female plantis may be observed in each separated individual parasite on the same host. The tetrasporangia, which are developed in the layer of cortex, are usually ellipsoid in shape. The sporangia are quite regularly, cruciately divided, when measured by the dimension by 10–15 $\mu \times$ 18–36 μ.

Fortunately, the authors could observe the many stages and the processes of the development of the cystocarps. Originally, the carpogonial branches issues from one of the cells in the outermost portion of the medullary. In all the specimens examined, we have found that it consists of three or four cells. The carpogonial branch, is slightly curved, being directly connected by the auxiliary cell lying beneath it. A procarp is formed by the carpogonial branch and the auxiliary cell. Before fertilization, the auxiliary cell becomes rather large and easily distinguishable from the normal vegetative cells. Generally the auxiliary cell is constantly accompanied with the row of nurlishing cells which consists of 2–3 small cells, and whose top cell is usually connected with the cortical cells. After fertilization, the auxiliary cell produces another two or three rows of nourishing cell groups and forms a large fusion-cell, which brings forth the gonimoblast. Then the gonimoblast gradually develops and is divided into many branches. And carpospores are gradually formed at the upper end of the branches of gonimoblast, but filaments of the lower part remain almost sterile in the form of slender filaments. The matured cystocarp is globose or semiglobose, 150–200 μ in diameter, and is formed in the outer-most portion of the medullary layer of the frond, and is devoid of pericarps. The measurement of carpospore is about 15 μ in diameter. The antheridial plant is unknown.

From the above mentioned characters it is assumed that the present species is a new parasitic one belonging to Gigartinales and not Cryptonemiales. About seven genera and many species of Rhodophyceae belonging to Gigartinales have been reported as parasites of the various members of Gigartinales. Generally speaking, almost all of the parasitic plants and their host plants, except several species, usually belong to the same order of Rhodophyceae. For example, *Lobocolax* belongs to exceptional ones, and yet according to Howe's description of *Lobocolax*, and judging from its character, this may also be made to belong to Nemalionales.

The main characteristics and chief differences observed in these three groups, namely, these seven genera, *Lobocolax* and present species, are shown in Table 1

Kintokiocolax Tanaka et Y. Nozawa, gen. nov.

Thallus in *Carpopeltis* parasiticus, tuberculiformes aut cerantiformes, dein hemiconfettiformes efficens, constans e filamentis multis in telam hospitis profunde penetrantibus;

Table 1.

	Shape of the frond	Basal part of the penetraing rhizoidal filaments	Tetraspore	Cystocarp	host
Gracilariophila Setchell & Wilson 1910	irregular spherical form	present (California) lack (Maly)	cruciate	with pericarp, wart-like surface	*Gracilaria, Gracilariopsis Corallopsis,Tylotus*
Plocamiocolax Setchell 1923	irregular spherical form			in resemblance to Plocamium, wart-like surface	*Plocamiums*
Gardneriella Kylin 1941	irregular spherical form with many projection	present	bispore only	without pericarp and carpostome, many carpogonial branches around the auxillary cell	*Agardniella*
Catienellocolax Weber van Bosse 1928	semispherical from				*Cattenella*
Hypneocolax Borgessen 1920	irregular spherical form	lack	zonate	wart-like surface	*Hypnea*
Celatocolax Weber van Bosse 1928	bush-like form	present	cruciate nemathecia -like	in resemblance to Phyllophora	*Phyllophora*
Graciariocolax Weber van Bosse 1928	irregular spherical with stem or not	lack	zonate ?	wart-like surface	*Gracilaria*
Lobocolax Howe 1914	semispherical cushion without stem	present	monospore only	in resemblance to Nemalionales	*Prionitis*
Kintokiocolax	hemiconfetto form without stem	present	cruciate	without pericarp, smooth surface	*Carpopeltis*

medulla filis cellulis magnis irregulariter ramosis formata; corticalis filis elongatis compactis radiato-verticilibus, simplicibus, strata cuticula in superficiem plus minus tenuis; procarpia non simplicia, pluricellularia; ramus carpogonialis 3–4 cellularis, trichogynis filiformibus, cellulis auxiliaribus magnibus, ante fertilizatioris; cystocarpia per frondem sparsa, globosa vel semiglobosa, plus minus minuta, in cryptis saepe pluriseriaris intra stratum medullae excavatis; tetrasporangia cruciate divisa; antheridia ignota;

Kintokiocolax aggregato-cerantha TANAKA et Y. NOZAWA, spec. nov.

Thallus in *carpopeltis angusta* (HARV.) OKAM. parasiticus, cartilageneous, ceranthus aut semiconfettiformes, 300 μ–1.5 mm in diam., 1–2 mm altus; constans e filamentis multis in telam hospitis profunde penetrantibus; strata corticula 6–7 stratosa, 40–70 μ crssa; cystocarpia globosa ovel semiglobosa, 150–200 μ in diam., in intra strata meddula formantia; tetrasporangia ellipsoidea, 10–15 $\mu \times$ 18–36 μ, cruciate divisa; antheridia ignota; colore pallido luteo-rubo aut porphyreo.

Japanese name; Kintoki-yadori.

Habitat and localities; Hananose, Kagoshima Prefecture. Growing on *Carpopeltis angusta* (HARV.) OKAMURA in the upper sublittoral zone. (Col. June 10th, 1959 and May 12th, 1960).

Frond parasitic on *Carpopeltis angusta* (HARV.) OKAM., cartilagenous, ceranthus or tubercularis when young, but hemiconfetto shape in matured, usually attached by many rhizoidal filaments which penetrate into the cortex of the host, but often fixed simply by flattened basal layer; penetrating rhizoidal filaments consisting of elongate cells, 180–200 μ in length; basal portion of the frond somewhat wart-like, 1–3 mm in diam., 500–700 μ in height, upper frond somewhat columnar, 300 μ–1.5 mm in diam., 1–2 mm in height, and rarely branched; structually, frond consisting of cortical and medullary tissue, cortical layer consists of 6–7 rows of small cells, 40–70 μ in thickness, medullary layer somewhat parenchymatic, consists of vertically elongated cells; carpogonial branch three or four celled, slightly curved, formed in the outermost part of the medullary layer; trichogyne usually straight and rather long; auxiliary cell rather large before fertilization, and directly connected with the carpogonial branch; cystocarp rather minute, globose or semiglobose and without pericarp, 150–200 μ in diam., formed in the outermost portion of the medullary layer; tetrasporangia ellipsoidal, 10–15 $\mu \times$ 18–36 μ, formed in the cortical layer; anthridia unknown; surface of the frond rather smooth; colour of the frond light yellowish red or purplish red.

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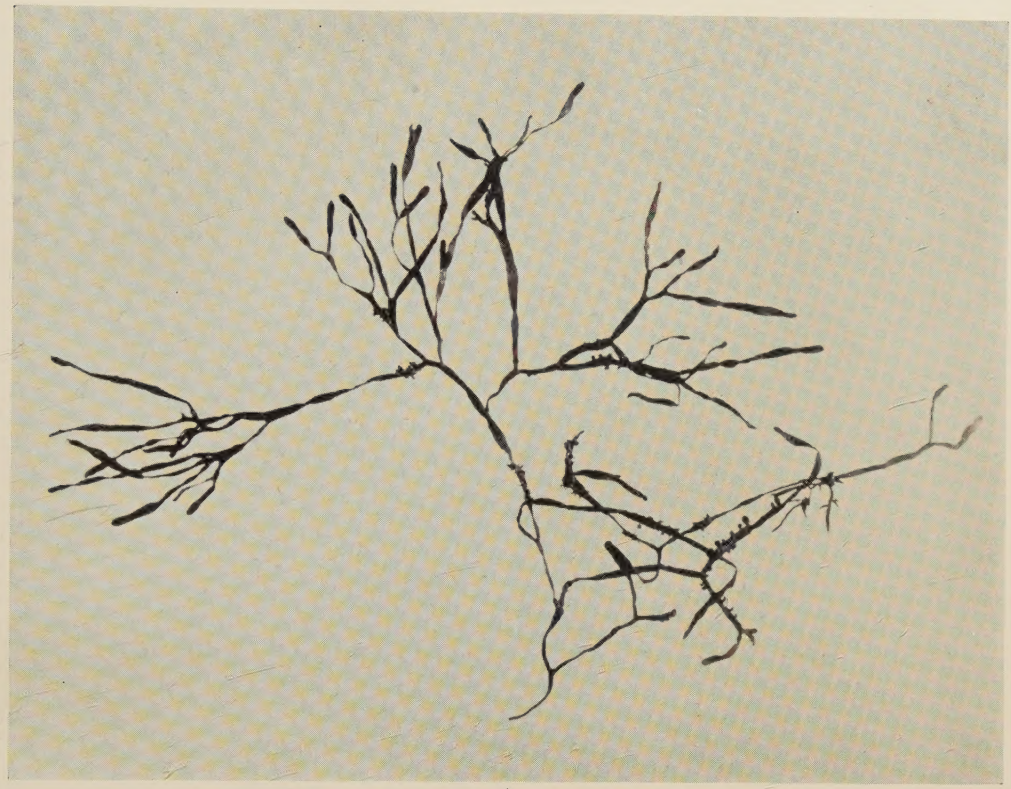

A

B C

Kintokiocolax aggregato-cerantha Tanaka et Y. Nozawa.

A. Parasitic plants growing on *Carpopeltis angusta* (Harv.) Okam. ×1.
B, C. Habits of parasitic fronds on the host plants. ×4.

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